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Selected "volatile" chlorinated hydrocarbons were quantified in more than 250 ambient air samples from 28 U.S. cities representing 10 states. Examination of the data reveals that their occurrence in the atmosphere may be regarded as either ubiquitous or site specific. Some of the representative ubiquitous halogenated compounds are methylene chloride, chloroform, carbon tetrachloride, 1,1-dichloroethane, 1,2-dichloroethane, trichloroethylene, chlorobenzene, tetrachloroethylene, dichlorobenzene isomers, and methyl chloroform.

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1.0 Introduction and Objectives

The Research Triangle Institute (RTI) over the past few years has collected many ambient air samples in the vicinity of industrial sources and other environments at various geographical areas within the Continental U. S. Under the sponsorship of EPA contracts, these samples have been characterized by gas chromatography/mass spectrometry/computer and data have been stored on computer tapes.

The methodology which has been developed and applied during the past few years for the characterization of ambient organic vapors utilizes a poly-pollutant concept whereby as many pollutants as possible are collected and analyzed. In this manner, a considerable amount of data is generated and selected portions are subjected to characterization and quantification. These data which have been placed in archival storage also contain much information about pollutants which have not been interpretated. An example is the concentration of halogenated organics in ambient air.

The prime objective of the service provided under this contract was to process information contained on these tapes and to determine the concentrations of a series of halogenated organics in ambient air samples. The compounds selected for quantification were methylene chloride, chloroform, carbon tetrachloride, vinyl chloride, vinylidene chloride, 1,2-dichloroethylene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, tetrachloroethylene, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, pentachloroethane, hexachloroethane, chlorobenzene, _o_-dichlorobenzene, _m_-dichlorobenzene, _p_-dichlorobenzene, 1,2,4-trichlorobenzene, 1,3,5-trichlorobenzene, and 1,2,5-trichlorobenzene. A minimum of 250 previously collected samples were quantified for these compounds which have not been previously reported in other contract reports. Furthermore, a compilation has been prepared of the concentration of halogenated compounds in all of the samples which have been analyzed to-date for the purpose of convenient comparison.

2.0 Experimental Methods

The techniques used for the collection of ambient air organic vapors has been previously described.(1,2,3) The technique which has been employed was developed over a period of approximately five years and should be regarded as a research tool. Improvements in the collection and analysis system is still an on-going research program and the data which has been acquired with this method are subject to these limitations.

Tables A1-A26 and Figures A1-A24 in Appendix A present the sampling protocols and the corresponding locations for the samples which were acquired and analyzed over the past two years under several EPA contracts. The methods for qualitative and quantitative analysis of these samples has been previously described(1,2) and the procedures are given in Appendix B.

3.0 Results and Discussion

Tables 1-29 present the concentrations of halogenated hydrocarbons which were measured at several locations within the industrial and non-industrial areas in the Continental U.S. The concentrations of halogenated hydrocarbons were in some cases determined in replicate samples and the reproducibility of the technique is given in each of the corresponding tables. In most cases, 2-4 blanks (control) cartridges were also analyzed to establish the lower limit of background occurring for this collection and analysis methodology. Table 30 presents a selected few examples of halogenated hydrocarbons which were loaded onto Tenax GC sampling cartridges, transported and stored in an identical fashion to the collected field samples and subsequently analyzed to determine the extent of recovery and thus the general accuracy of the technique.

The highest concentrations of halogenated hydrocarbons occurred in areas containing industrial disposal sites or near heavily industrialized sites.

Table 1. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM KIN-BUC DISPOSAL SITE, EDISON, NJ (PERIODS 1 & 2)[a]

	Sampling Period/Location[b]							
Chemical	P1/L1	P1/L2	P1/L3	P1/L4	P2/L1	P2/L2	P2/L3	P2/L4
methylene chloride	<1000	<1000	<1000	T(1000)	T(3750)	T(3750)	T(3750)	T(3750)
chloroform	6389	T(230)	T(230)	T(230)	1999	T(230)	T(230)	<230
carbon tetrachloride	<111	<153	1312	750	12687	13687	7250	1937
vinyl chloride	<18750	<15000	<15000	<15000	<18750	<18750	<18750	<18750
vinylidene chloride	<555	<454	<454	<454	<555	<555	<555	<555
1,2-dichloroethylene	<555	<454	<454	<454	4947	4500	5263	T(565)
1,1-dichloroethane	<470	<364	<364	<364	<470	<470	<470	<470
1,2-dichloroethane	<348	<381	<381	217	T(150)	434	T(347)	2173
1,1,1-trichloroethane	T(417)	NQ	T(417)	T(417)	T(555)	T(417)	T(417)	T(417)
1,1,2-trichloroethane	<294	<294	294	294	<357	<357	<357	<357
trichloroethylene	T(131)	210	1315	10052	4947	4500	5263	T(178)
tetrachloroethylene	354	1527	T(45)	T(45)	1187	T(49)	2896	T(49)
1,1,1,2-tetrachloroethane	<53	<45	<38	<38	<54	<34	<32	<32
1,1,2,2-tetrachloroethane	<53	<45	<38	<38	<54	<34	<32	<32
pentachloroethane	<45	<37	<32	<36	<45	<28	<27	<26
hexachloroethane	<45	<37	<32	<36	<45	<28	<27	<26
chlorobenzene	170	112	<96	507	T(135)	T(85)	T(82)	1127
o-dichlorobenzene	<89	1873	<64	77	<90	T(57)	<55	<53
m-dichlorobenzene	205	33783	244	<64	T(90)	205	<55	<53
p-dichlorobenzene	<80	<67	<58	<58	<81	<51	<49	<48

(continued)

Table 1 (cont'd)

Chemical	Sampling Period/Location							
	P1/L1	P1/L2	P1/L3	P1/L4	P2/L1	P2/L2	P2/L3	P2/L4
1,2,4-trichlorobenzene	<53	<45	<38	<58	<54	<34	<32	<32
1,3,5-trichlorobenzene	<45	<37	<32	<36	<45	<28	<27	<26
1,2,5-trichlorobenzene	<53	<45	<38	<38	<54	<34	<32	<32

[a] See Table A1 and Figures A1 and A2 for sampling protocol and locations.

[b] T = trace, ( ) and < indicates limit of detection. All values in ng/m^3.

Table 2. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM KIN-BUC DISPOSAL SITE, EDISON, NJ (PERIODS 3 & 4)[a]

	Sampling Period/Location[b]						
Chemical	P3/L1	P3/L2	P3/L3	P3/L4	P4/L2	P4/L3	P4/L4
methylene chloride	7600	T(1000)	T(1000)	T(1000)	T(1250)	T(1250)	T(1250)
chloroform	9000	1944	12333	3445	5834	8999	2778
carbon tetrachloride	T(125)	T(125)	T(125)	2000	1875	7625	T(153)
vinyl chloride	<15000	<15000	<15000	<15000	<18750	<18750	<18750
vinylidene chloride	<454	<454	<454	T(454)	<588	<588	<555
1,2-dichloroethylene	<454	<454	<454	<454	<588	<588	<555
1,1-dichloroethane	<476	<476	<476	<476	<470	<470	<470
1,2-dichloroethane	37913	<347	T(347)	347	T(444)	1130	<444
1,1,1-trichloroethane	<417	<417	19167	158	T(556)	7684	T(555)
1,1,2-trichloroethane	3500	<294	<294	<294	<357	<357	<357
trichloroethylene	3737	T(178)	6895	10315	394	5289	T(214)
tetrachloroethylene	<50	291	2847	<49	527	9173	1389
1,1,1,2-tetrachloroethane	<43	<32	<34	<34	<34	<30	<40
1,1,2,2-tetrachloroethane	<43	<32	<34	<34	<34	<30	<40
pentachloroethane	<36	<27	<28	<26	<20	<25	<27
hexachloroethane	<36	<27	<28	<26	<20	<25	<27
chlorobenzene	<109	167	480	1807	T(60)	607	610
o-dichlorobenzene	<72	<53	341	942	<40	150	T(54)
m-dichlorobenzene	T(72)	<53	376	895	T(40)	410	T(54)
p-dichlorobenzene	<65	<48	<48	<47	<36	<45	<49

(continued)

Table 2 (cont'd)

Chemical	Sampling Period/Location						
	P3/L1	P3/L2	P3/L3	P3/L4	P4/L2	P4/L3	P4/L4
1,2,4-trichlorobenzene	<43	<32	<34	<34	<34	<30	<32
1,3,5-trichlorobenzene	<36	<27	<28	<26	<20	<25	<27
1,2,5-trichlorobenzene	<43	<32	<34	<34	<34	<30	<32

[a] See Table A1 and Figures A3 and A4 for sampling protocol and location.

[b] Values are in ng/m^3, T = trace, ( ) and < indicates limit of detection.

Table 3. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM KIN-BUC DISPOSAL SITE, EDISON, NJ (PERIODS 5 & 6)[a]

Chemical	Sampling Period/Location[b]							
	P5/L1	P5/L2	P5/L3	P5/L4	P6/L1	P6/L2	P6/L3	P6/L4
methylene chloride	T(1000)	T(1000)	40000	100000	3000	T(1000)	260000	42000
chloroform	17222	11111	19444	8334	944	2500	27200	28334
carbon tetrachloride	<125	<125	<125	7000	3125	625	10600	7000
vinyl chloride	<15000	<15000	<15000	<15000	<15000	<16667	<16667	<16667
vinylidene chloride	<454	<454	<454	<454	<454	<500	<500	<500
1,2-dichloroethylene	<454	<454	<454	<454	<454	<500	<500	<500
1,1-dichloroethane	<380	<380	<421	<421	<421	<320	22700	<400
1,2-dichloroethane	T(348)	<348	7575	9565	T(347)	<276	27700	260
1,1,1-trichloroethane	T(417)	T(417)	3417	~150000	T(417)	<417	121000	75000
1,1,2-trichloroethane	<294	<294	<263	4467	<294	<444	<263	<312
trichloroethylene	T(132)	T(132)	18,940	3684	T(132)	T(132)	T(263)	10606
tetrachloroethylene	1360	152	25560	34632	694	1229	394000	12500
1,1,1,2-tetrachloroethane	<52	<29	<29	<34	<50	<33	<315	<29
1,1,2,2-tetrachloroethane	<52	<29	<29	22285	<50	<33	15000	1389
pentachloroethane	<44	<25	<25	<22	<42	<28	<263	<24
hexachloroethane	<44	<25	<25	<22	<42	<28	<263	<24
chlorobenzene	T(132)	T(74)	T(74)	12791	T(77)	T(83)	2656	918
o-dichlorobenzene	<88	T(49)	1526	5087	1500	T(55)	9899	300
m-dichlorobenzene	T(88)	T(49)	789	839	659	T(55)	3526	T(48)
p-dichlorobenzene	<79	<45	<45	<39	75	<50	474	<43

(continued)

Table 3 (cont'd)

Chemical	Sampling Period/Location							
	P5/L1	P5/L2	P5/L3	P5/L4	P6/L1	P6/L2	P6/L3	P6/L4
1,2,4-trichlorobenzene	<52	<30	<30	T(26)	<50	<33	<315	<29
1,3,5-trichlorobenzene	<44	<25	<25	<22	<42	<28	<263	T(24)
1,2,5-trichlorobenzene	<52	<30	<30	<26	<50	<33	<315	<29

[a] See Table A1 and Figures A5 and A6 for sampling protocol and locations.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection.

Table 4. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM KIN-BUC DISPOSAL SITE[a]

Chemical	Period/Location[b]					
	P1/L1	P2/L2	P3/2	P4/KB	P4/L5	P5/4
vinyl chloride	<10714	<10000	<10714	T(11538)	<10000	<10000
1,1-dichloroethane	<250	<228	<267	<444	<195	<195
1,1,1,2-tetrachloroethane	<22	<20	<20	<22	<20	<20
1,1,2,2-tetrachloroethane	<22	<20	<20	<22	<20	<20
pentachloroethane	<17	<17	<17	<84	<17	<8
hexachloroethane	<17	<17	<17	<84	<17	<8
o-dichlorobenzene	6320	T(33)	250	12433	<33	58
m-dichlorobenzene	<33	T(33)	143	26583	<33	126
p-dichlorobenzene	7000	<30	<30	<150	<30	<10
1,2,4-trichlorobenzene	167	<20	<20	<100	<20	<20
1,3,5-trichlorobenzene	1160	<17	<17	<84	<17	<8
1,2,3-trichlorobenzene	<22	<20	<20	<100	<20	<20
vinylidene chloride	<294	<263	<294	<294	<285	<263
1,1,2-trichloroethane	17571	<217	<238	11435	<217	<217

[a] See Table A2 and Figure A7 for sampling protocol and locations.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection.

Table 5. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR IN NEW JERSEY[a]

Chemical	City					
	Paterson	Hoboken	Clifton	Fords	Passaic	Sayreville
methylene chloride	1091[b]	<454	1545	9286	400	14444
carbon tetrachloride	<59	833	T(59)	334	<50	555
1,2-dichloroethane	<212	<58	<213	<334	<192	<263
1,1-dichloroethane	<200	<160	<160	<285	<145	<228
1,1,2-trichloroethane	<167	<167	<167	<250	<167	<217
1,1,1,2-tetrachloroethane	<20	<20	<20	<24	<20	<22
1,1,2,2-tetrachloroethane	<20	<20	<20	<24	<20	2872
pentachloroethane	<17	<17	<17	<17	<17	<10
hexachloroethane	<17	<17	<17	<17	<17	<10
o-dichlorobenzene	<33	T(33)	<33	<34	<33	106
m-dichlorobenzene	T(33)	T(33)	<33	<34	T(33)	157
p-dichlorobenzene	<30	<30	<30	<34	<30	<9

[a] See Table A3 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection.

Table 6. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM TULSA, OK[a]

Chemical	Sample Code[b]						
	LM-1	DT-1	B	LM-2	DT-2	V-1	B
carbon tetrachloride	T(125)	<154	≤2	T(95)	T(95)	T(143)	<2
vinyl chloride	<15000	<18750	<15	<12000	<12000	<16667	<15
vinylidene chloride	T(454)	<555	≤10	<334	<334	<500	<10
1,2-dichloroethylene	<454	<555	<10	<334	<334	<500	<10
1,1-dichloroethane	<381	<470	<8	<286	<286	<421	<8
1,2-dichloroethane	<348	<444	<8	T(258)	<258	<400	<8
1,1,1-trichloroethane	T(417)	<556	<5	T(334)	T(334)	T(454)	<5
1,1,2-trichloroethane	<294	<357	<5	<250	<250	<312	<5
trichloroethylene	<132	<178	<5	T(100)	T(100)	T(151)	≤5
tetrachloroethylene	<49	<66	≤7	<36	T(36)	T(54)	<7
1,1,1,2-tetrachloroethane	<38	<42	<6	<24	<24	<24	<6
1,1,2,2-tetrachloroethane	<38	<42	<6	<24	<24	<24	<6
pentachloroethane	<31	<35	<5	<14	<13	<13	<5
hexachloroethane	<31	<35	<5	<14	<13	<13	<5
chlorobenzene	<93	<107	<15	T(42)	<43	50 ± 11	<15
o-dichlorobenzene	<62	<70	<10	100 ± 72	T(28)	<26	<10
m-dichlorobenzene	<62	<70	<10	81 ± 39	<28	T(26)	<10
p-dichlorobenzene	<56	<63	<9	<26	<26	<23	<9

(continued)

Table 6 (cont'd)

Chemical	Sample Code						
	LM-1	DT-1	B	LM-2	DT-2	V-1	B
1,2,4-trichlorobenzene	<38	<42	<6	<17	<17	<15	<6
1,3,5-trichlorobenzene	<31	<35	<5	<14	<13	<13	<5
1,2,3-trichlorobenzene	<38	<42	<6	<17	<17	<15	<6

[a] See Table A4 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection.

Table 7. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM HOUSTON, TX[a]

Chemical	Sample Code[b]								
	TC1	HC1	HC2	TC2	TC3	HC5	HC3	HC4	B
methylene chloride	4375 ± 3125	2736 ± 1014	1100 ± 100	1000 ± 0	3428	4500 ± 1643	4142 ± 428	1000	≤5
chloroform	3884 ± 2884	2064 ± 397	292 ± 125	400 ± 25	500 ± 333	T(125)	327 ± 77	354 ± 146	≤3
carbon tetrachloride	T(154)	217 ± 63	T(125)	T(125)	T(95)	T(95)	T(95)	T(95)	≤2
vinyl chloride	<18750	<18750	<15000	<15000	<12000	<12000	<12000	<12000	<15
1,2-dichloroethylene	<555	4525 ± 1747	T(454)	<454	297 ± 37	T(334)	<(334)	T(334)	<10
1,1-dichloroethane	<471	<471	<381	<381	<357	<285	<285	<285	<8
1,2-dichloroethane	T(444)	<348	T(348)	<348	T(258)	T(258)	209 ± 48	T(258)	<8
1,1,1-trichloroethane	T(555)	708 ± 41	533 ± 116	995 ± 5	T(533)	T(334)	T(334)	T(334)	≤5
trichloroethylene	<179	T(179(	T(132)	158 ± 26	<100	T(250)	72 ± 28	T(250)	≤5
tetrachloroethylene	T(55)	69 ± 8	T(79)	<123	252 ± 130	T(46)	262 ± 77	250 ± 0	<5
1,1,1,2-tetrachloroethane	<67	<75	<95	<105	<67	<(55)	<53	<89	<6
1,1,2,2-tetrachloroethane	<67	<75	<95	<105	<67	<55	<53	<89	<6
pentachloroethane	<55	<62	<69	<88	<56	<46	<44	<75	<5
hexachloroethane	<55	<62	<79	<88	<56	<46	<44	<75	<5
chlorobenzene	<167	<187	T(283)	<263	T(168)	T(139)	T(132)	T(224)	<15
o-dichlorobenzene	<110	<125	<159	<175	T(112)	T(92)	T(88)	<149	<10
m-dichlorobenzene	T(110)	T(127)	T(159)	T(175)	T(112)	T(92)	T(88)	T(149)	<10
p-dichlorobenzene	<99	<112	<143	<158	<101	<(83)	<80	<134	<9
1,2,4-trichlorobenzene	<67	<75	<95	<123	<67	T(55)	<53	<89	<6
1,3,5-trichlorobenzene	<55	<62	<79	<88	<56	T(46)	<44	T(75)	<5
1,2,3-trichlorobenzene	<67	<75	<95	<123	<67	<55	<53	<89	<6
vinylidene chloride	<555	<555	<454	427 ± 27	<334	<334	T(334)	<334	<10
1,1,2-trichloroethane	<357	<357	<294	<294	<250	<250	<250	<334	<5

[a] See Table A5 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection.

Table 8. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM THE KANAWHA VALLEY, WV[a]

Chemical	Period/Location[b]								
	P1/L1	P1/L2	P1/L3	P1/L4	P1/L5	P2/L2	P2/L3	P2/L5	P2/L6
methylene chloride	T(1000)	T(1000)	T(714)	T(714)	<625	T(555)	778	<555	<555
chloroform	T(167)	T(167)	T(125)	T(125)	<120	T(97)	T(97)	<97	<97
carbon tetrachloride	<625	T(125)	<95	T(95)	<91	T(74)	T(74)	<74	<74
vinyl chloride	<15000	<12000	<12000	<12000	<10000	<10000	<10000	<10000	<10000
1,2-dichloroethylene	<545	<334	T(334)	<334	T(322)	<322	T(322)	<263	<263
1,1-dichloroethane	<380	<286	<285	<285	<345	<345	<345	<228	<228
1,2-dichloroethane	T(347)	T(258)	<258	<258	T(250)	<256	<256	<195	<195
1,1,1-trichloroethane	T(417)	T(334)	T(334)	T(334)	T(312)	T(312)	T(312)	<278	<278
1,1,2-trichloroethane	<294	<250	<250	<250	<238	-	<217	<218	<218
trichloroethylene	T(132)	T(100)	<100	300	<98	T(98)	T(98)	<74	<74
tetrachloroethylene	T(48)	T(35)	T(36)	<36	T(36)	146	T(26)	<26	<26
1,1,1,2-tetrachloroethane	<23	<31	<31	<31	<30	<30	<30	<22	<22
1,1,2,2-tetrachloroethane	<23	<31	<31	<31	<30	<30	<30	<22	<22
pentachloroethane	<13	<8	<9	<10	<9	<9	<9	<9	<12
hexachloroethane	<13	<8	<9	<10	<9	<9	<9	<9	<12
chlorobenzene	<58	<25	<27	T(32)	<32	<32	<32	<27	<36
o-dichlorobenzene	<39	T(17)	<18	<20	<18	T(18)	<18	<18	<24
m-dichlorobenzene	<39	T(28)	T(18)	T(20)	T(18)	38	<14	<18	<24
p-dichlorobenzene	<35	<15	<16	<18	<16	<16	-	<17	<30
1,2,4-trichlorobenzene	<23	<10	<11	<12	<11	<11	<8	<11	<15
1,3,5-trichlorobenzene	<13	<8	<9	<10	<9	<9	<7	<9	<12
1,2,3-trichlorobenzene	<23	<10	<11	<12	<11	<11	<8	<11	<15
vinylidene chloride	<454	<334	<334	<334	<345	<345	<345	<263	<263

[a] See Tables A6 and A7 and Figures A8-A12 for sampling protocol and locations.

[b] T = trace, values in parenthesis indicate detection limit, and < = not detected at indicated detection limit. Values are in ng/m^3.

Table 9. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM THE KANAWHA VALLEY, WV[a]

Chemical	Period/Cycle[b]									
	P1/L1	P1/L2	P1/L3	P1/L4	P1/L5	P2/L2	P2/L3	P2/L4	P2/L5	B
methylene chloride	867	715	T(714)	T(714)	T(714)	11334	T(555)	T(555)	1778	≤7
chloroform	177	T(125)	T(125)	T(125)	T(125)	2161	161	1333	T(97)	≤3
carbon tetrachloride	215	T(95)	T(95)	T(95)	T(95)	2222	3630	97	T(74)	≤2
vinyl chloride	<10000	<12000	<12000	<12000	<12000	<10000	<10000	<10000	<10000	<15
1,2-dichloroethylene	T(263)	<334	<334	T(334)	T(334)	T(263)	<263	<263	T(263)	≤10
1,1-dichloroethane	<228	<228	<228	<228	<228	<228	<228	<228	<228	<8
1,2-dichloroethane	T(195)	T(258)	<258	T(258)	<258	T(195)	T(195)	T(195)	T(195)	≤8
1,1,1-trichloroethane	278	T(334)	T(334)	T(334)	T(334)	3278	T(278)	T(278)	<278	≤5
1,1,2-trichloroethane	<217	<250	<250	<250	<250	<217	<217	<217	<217	<5
trichloroethylene	<74	<100	<100	360	T(100)	179	45	358	T(75)	≤5
tetrachloroethylene	109	T(36)	<36	T(360)	T(36)	1536	434	52	<26	<7
1,1,1,2-tetrachloroethane	<22	<31	<31	<31	<31	<20	<22	<22	<22	<6
1,1,2,2-tetrachloroethane	<22	<31	<31	<31	<31	<20	<22	<22	<22	<6
pentachloroethane	<10	<19	<13	<13	<12	<17	<12	<12	<9	<5
hexachloroethane	<10	<19	<13	<13	<12	<17	<12	<12	<9	<5
chlorobenzene	T(29)	T(56)	<40	<40	T(36)	44	<35	T(37)	<26	<15
o-dichlorobenzene	<19	T(37)	<27	T(27)	<24	306	T(23)	39	<17	<10
m-dichlorobenzene	101	T(37)	<27	T(27)	T(24)	276	T(23)	T(24)	<17	<10
p-dichlorobenzene	<18	<34	<24	<24	<22	T(33)	<21	<22	<16	<9
1,2,4-trichlorobenzene	<12	<22	<16	<16	<14	<20	<14	<15	<12	<6
1,3,5-trichlorobenzene	<10	<19	<13	<13	<12	<17	<12	<12	<9	<5
1,2,3-trichlorobenzene	<12	<22	<16	<16	<14	<20	<14	<15	<12	<6
vinylidene chloride	T(263)	<334	<334	<334	<334	<263	<263	<263	<263	<10

[a] See Tables A6 and A8 and Figures A8-A12 for sampling protocol and locations.

[b] T = trace, values in parenthesis indicate detection limit, and < = not detected at indicated detection limit. Values are in ng/m^3.

Table 10. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM THE KANAWHA VALLEY, WV[a]

Chemical	Period/Location[b]									
	P1/L1	P2/L2	P2/L5	P2/L7	P2/L8	P3/L8	P3/L2	P3/L5	P3/L8	P3/L9
methylene chloride	2818	T(454)	T(454)	T(454)	4091	1636	9818	1272	1636	1600
chloroform	428	T(71)	T(71)	T(71)	333	T(71)	262	T(71)	T(71)	T(71)
carbon tetrachloride	529	T(59)	T(59)	T(59)	441	T(59)	500	T(59)	T(59)	T(59)
vinyl chloride	<7500	<7500	<7500	<7500	<7500	<7500	<7500	<7500	<7500	<7500
1,2-dichloroethylene	T(212)	T(213)	T(212)	T(213)	T(213)	T(213)	T(213)	<213	<213	T(213)
1,1-dichloroethane	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160
1,2-dichloroethane	T(151)	151	T(163)	T(151)	T(151)	T(151)	T(151)	T(151)	T(151)	T(151)
1,1,1-trichloroethane	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)	347	T(217)
1,1,2-trichloroethane	<167	<167	<94	<167	<167	<167	<167	<167	<167	<167
trichloroethylene	T(56)	T(56)	T(55)	T(55)	T(55)	T(55)	T(55)	T(55)	T(55)	<144
tetrachloroethane	T(20)	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)
pentachloroethane	<14	<6	<6	<6	<6	<6	<6	<6	<6	<6
hexachloroethane	<14	<6	<6	<6	<6	<6	<6	<6	<6	<6
chlorobenzene	<44	<17	T(18)	T(18)	T(18)	T(18)	T(18)	T(18)	T(18)	T(18)
o-dichlorobenzene	<29	<9	T(8)	T(12)	59	<9	T(9)	T(9)	T(9)	T(9)
m-dichlorobenzene	<29	<16	T(8)	T(12)	T(12)	<18	<9	T(9)	T(9)	T(9)
p-dichlorobenzene	<26	<8	<7	<7	<7	<7	<7	<7	<7	<7
1,2,4-trichlorobenzene	<17	<6	<7	<7	<7	<7	<7	<7	<7	<7
1,3,5-trichlorobenzene	<14	<6	<6	<6	<6	<6	<6	<6	<6	<6
1,2,3-trichlorobenzene	<17	<6	<7	<7	<7	<7	<7	<7	<7	<7
vinylidene chloride	<212	<213	<212	<213	<213	<213	<213	<213	<213	<213
1,1,1,2-tetrachloroethane	<17	<15	<17	<16	<16	<16	<16	<16	<16	<16
1,1,2,2-tetrachloroethane	<17	<16	<17	<16	<16	<16	<16	<16	<16	<16

[a] See Table A6 and A9 and Figures A8-A12 for sampling protocol and locations.

[b] T = trace, values in parenthesis indicate detection limit, and < = not detected at indicated detection limit. Values are in ng/m^3.

Table 11. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM FRONT ROYAL, VA[a]

Chemical	Period/Location[b]								
	P1/L1	P1/L2	P1/L3	P1/L4	P2/L3	P2/L5	P3/L2	P3/L6	B
methylene chloride	1000	T(714)	1857	2143	97627	2444	4600	1000	~6
chloroform	T(125)	125	125	208	4800	149	278	T(125)	≤3
carbon tetrachloride	<95	<95	T(95)	<95	190	T(74)	T(125)	T(95)	≤2
vinyl chloride	<12000	<12000	<12000	<12000	<11538	<10000	<15000	<12000	<15
1,2-dichloroethylene	T(334)	<334	<334	T(500)	<357	<263	<454	<334	≤10
1,1-dichloroethane	<285	<285	<285	<285	<258	<228	<476	<285	<8
1,2-dichloroethane	<258	<258	<258	<258	<500	<195	T(348)	<258	≤8
1,1,1-trichloroethane	T(334)	T(100)	T(334)	T(334)	381	T(278)	<667	T(334)	<5
1,1,2-trichloroethane	<250	<334	<250	<250	<98	<217	<294	<250	<5
trichloroethylene	<100	<100	<100	T(100)	T(98)	T(74)	T(132)	<100	≤5
tetrachloroethylene	T(36)	20	<36	T(36)	132	26	35	31	<7
1,1,1,2-tetrachloroethane	<22	<30	<30	<30	<30	<22	<40	<30	<6
1,1,2,2-tetrachloroethane	<22	<30	<30	<30	<30	<22	<40	<30	<6
pentachloroethane	<7	<15	<8	<22	<7	<9	<9	<15	<5
hexachloroethane	<7	<15	<8	<22	<7	<9	<9	<15	<5
chlorobenzene	<32	<45	<32	<66	<32	T(26)	T(44)	<46	<15
o-dichlorobenzene	<14	<30	<18	<44	T(13)	T(18)	<18	T(31)	<10
m-dichlorobenzene	<14	T(27)	T(18)	22	8	T(18)	T(17)	T(31)	<10
p-dichlorobenzene	<13	<27	<15	<39	<12	<16	<16	<28	<9
1,2,4-trichlorobenzene	<8	<18	<9	<26	<8	<10	<10	<10	<6
1,3,5-trichlorobenzene	<7	<15	<8	<22	<7	<9	<9	<15	<5
1,2,5-trichlorobenzene	<8	<18	<9	<26	<8	<10	<10	<18	<6
vinylidene chloride	<334	<334	<334	T(500)	2500	<263	778	<334	<10

[a] See Tables A10 and A11 and Figures A13 for sampling protocol and locations.

[b] T = trace, values in parenthesis indicate detection limit, and < = not detected at indicated detection limit. Values are in ng/m^3.

Table 12. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM FRONT ROYAL, VA[a]

Chemical	Period/Location[b]								
	P2/L1	P2/L2	P2/L3	P2/L4	P2/L5	P3/L1	P3/L2	P3/L3	P3/L5
methylene chloride	8375	40571	11428	120142	87375	25250	2625	111556	238250
chloroform	692	792	T(125)	2708	1807	711	T(115)	2193	14517
carbon tetrachloride	217	T(95)	T(95)	1190	T(87)	T(87)	565	889	280
vinyl chloride	<12000	<12000	<12000	<12000	<11750	<12000	<11750	<10000	<11500
1,2-dichloroethylene	T(312)	T(334)	T(334)	T(334)	T(312)	T(312)	T(312)	1842	2974
1,1-dichloroethane	<267	<285	<285	<285	<267	<267	<334	<263	<242
1,2-dichloroethane	T(242)	T(258)	T(258)	322	<242	T(242)	T(242)	<228	<205
1,1,1-trichloroethane	T(294)	800	T(334)	2933	T(294)	T(470)	T(470)	195	T(312)
1,1,2-trichloroethane	<227	<250	<250	<250	<227	<363	<227	2500	<238
trichloroethylene	T(96)	T(100)	T(100)	420	<96	T(96)	T(96)	<218	T(77)
tetrachloroethylene	380	332	36	2994	T(36)	163	35	388	77
1,1,1,2-tetrachloroethane	<15	<30	<30	<33	<30	<16	<27	810	<22
1,1,2,2-tetrachloroethane	<15	<30	<30	<33	<30	<16	<27	<22	<22
pentachloroethane	<12	<12	<11	<27	<11	<13	<8	<22	<6
hexachloroethane	<12	<12	<11	<27	<11	<13	<8	<7	<6
chlorobenzene	T(38)	T(36)	T(32)	T(82)	<33	<39	<32	<7	<18
o-dichlorobenzene	58	T(24)	T(21)	T(55)	<22	<26	<15	38	<12
m-dichlorobenzene	35	T(24)	T(21)	279	<22	T(26)	<15	T(14)	<12
p-dichlorobenzene	<23	<22	<19	<49	<20	<23	<14	68	<10
1,2,4-trichlorobenzene	<15	<14	<13	<33	<13	<16	<9	<13	<7
1,3,5-trichlorobenzene	<12	<12	<11	<27	<11	<13	<8	<9	<6
1,2,5-trichlorobenzene	<15	<14	<13	<33	<13	<16	<9	<7	<7
vinylidene chloride	<312	334	<334	<334	<312	<312	<312	<9	<27

[a] See Tables A10 and A12 and Figure A13 for sampling protocol and locations.

[b] T = trace, values in parenthesis indicate detection limit, and < = not detected at indicated detection limit. Values are in ng/m^3.

Table 13. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM FRONT ROYAL, VA[a]

Chemical		Period/Cycle[b]								
	B	P1/L2	P1/L4	P1/L7	P1/L8	P1/L9	P2/L2	P2/L7	P2/L8	P2/L9
methylene chloride	≤5	1364	T(454)	2545	<454	1091	1818	2090	6273	<454
chloroform	≤3	T(71)	<71	<71	<71	<71	<71	T(71)	119	<71
carbon tetrachloride	<2	<59	T(59)	<59	<59	<59	T(59)	<59	T(59)	<59
vinyl chloride	<15	<7500	<7500	<7500	<7500	<7500	<7500	<7500	<7500	<7500
1,2-dichloroethylene	<10	T(213)	T(213)	T(213)	<213	T(213)	T(213)	T(213)	T(213)	T(213)
1,1-dichloroethane	<8	<160	<160	<160	<160	<160	<160	<160	<160	<160
1,2-dichloroethane	≤8	T(151)	<151	T(151)	<151	T(151)	T(151)	T(151)	T(151)	T(151)
1,1,1-trichloroethane	≤5	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)
1,1,2-trichloroethane	<5	<167	<167	<167	<167	<167	<167	<167	<167	<167
trichloroethylene	<5	T(155)	T(155)	T(155)	T(155)	T(155)	T(155)	T(155)	T(155)	T(155)
tetrachloroethylene	<7	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)	T(19)
1,1,1,2-tetrachloroethane	<6	<16	<16	<16	<16	<16	<16	<16	<16	<16
1,1,2,2-tetrachloroethane	<6	<16	<16	<16	<16	<16	<16	<16	<16	<16
pentachloroethane	<5	<6	<6	<6	<6	<6	<6	<6	<6	<6
hexachloroethane	<5	<6	<6	<6	<6	<6	<6	<6	<6	<6
chlorobenzene	≤15	T(18)	T(18)	T(18)	T(18)	T(18)	T(18)	T(18)	T(18)	T(18)
o-dichlorobenzene	<10	T(9)	<9	T(9)	T(9)	T(9)	T(9)	T(9)	T(9)	T(9)
m-dichlorobenzene	<10	T(9)	T(9)	T(9)	T(9)	T(9)	T(9)	T(9)	T(9)	T(9)
p-dichlorobenzene	<9	<7	<7	<7	<7	<7	<7	<7	<7	<7
1,2,4-trichlorobenzene	<6	<7	<7	T(7)	<7	<7	<7	<7	<7	<7
1,3,5-trichlorobenzene	<5	<6	<6	<6	<6	<6	<6	<6	<6	<6
1,2,3-trichlorobenzene	<6	<7	<7	<7	<7	<7	<7	<7	<7	<7
vinylidene chloride	<10	<213	<213	<213	<213	<213	<213	<213	<213	<213

[a] See Tables A10 and A13 and Figure A13 for sampling protocol and locations.

[b] T = trace, values in parenthesis indicate detection limit, and < = not detected at indicated detection limit. Values are in ng/m^3.

Table 14. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM SOUTH CHARLESTON, WV[a]

Chemical	Sample Code[b]					
	SC-1	SC-2	SC-3	SC-4	SC-5	B
methylene chloride	821 ± 107	T(714)	T(714)	T(714)	T(714)	≤5
chloroform	416 ± 162	425 ± 200	478 ± 188	383 ± 129	826 ± 131	<11
carbon tetrachloride	T(95)	T(95)	T(95)	T(95)	T(95)	<2
vinyl chloride	<12000	<12000	<12000	<12000	<12000	<15
vinylidene chloride	<334	<334	<334	<334	<334	<10
1,2-dichloroethylene	<334	<334	<334	<334	<334	<10
1,1-dichloroethane	<357	<357	<357	<357	<357	<8
1,2-dichloroethane	<258	<258	T(258)	<258	<258	<8
1,1,1-trichloroethane	5026 ± 1093	2663 ± 270	2300 ± 167	2867 ± 400	1820 ± 580	≤5
1,1,2-trichloroethane	<250	<250	<250	<250	<250	<5
trichloroethylene	<100	<100	<100	<100	<100	<5
tetrachloroethylene	<132	<104	<104	<104	<163	<7
1,1,1,2-tetrachloroethane	<113	<128	<128	<128	<139	<6
1,1,2,2-tetrachloroethane	<113	<128	<128	<128	<139	<6
pentachloroethane	<94	<106	<106	<106	<116	<5
hexachloroethane	<94	<106	<106	<106	<116	<5
chlorobenzene	<283	<319	<319	T(319)	T(349)	<15
o-dichlorobenzene	<189	<213	<213	<213	<232	<10
m-dichlorobenzene	<189	<213	<213	<213	<232	<10
p-dichlorobenzene	<169	<191	<191	<191	<209	<9

(continued)

Table 14 (cont'd)

Chemical	Sample Code					
	SC-1	SC-2	SC-3	SC-4	SC-5	B
1,2,4-trichlorobenzene	<113	<128	<128	<128	<139	<6
1,3,5-trichlorobenzene	<94	<106	<106	<106	<116	<5
1,2,5-trichlorobenzene	<113	<128	<128	<128	<139	<6

[a] See Table A14 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection. Duplicate analysis.

Table 15. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM BIRMINGHAM, AL[a]

Chemical	Sample Code[b]					
	BR-1	BR-2	BR-3	BR-4	BR-5	B
methylene chloride	286	<715	<715	T(715)	1071 ± 357	<5
chloroform	375	146 ± 21	<125	T(125)	1096 ± 690	<3
carbon tetrachloride	<95	T(95)	<95	T(95)	T(95)	<2
vinyl chloride	<12000	<10000	<12000	<12000	<12000	<15
1,2-dichloroethylene	<300	<450	<334	<334	<334	<10
1,1-dichloroethane	<285	<381	<285	<285	<285	<10
1,2-dichloroethane	<258	205 ± 12	399 ± 52	<258	<258	<8
1,1,1-trichloroethane	2267	2067 ± 267	2100 ± 233	1867	T(334)	<5
1,1,2-trichloroethane	<250	<250	<250	<250	<250	<5
trichloroethylene	T(100)	134 ± 2	T(100)	T(100)	T(100)	<5
tetrachloroethylene	T(25)	58 ± 7	T(65)	T(65)	T(65)	<7
1,1,1,2-tetrachloroethane	<113	<50	<56	<56	<56	<6
1,1,2,2-tetrachloroethane	<113	<50	<56	<56	<56	<6
pentachloroethane	<94	<46	<46	<46	<46	<5
hexachloroethane	<94	<46	<46	<46	<46	<5
chlorobenzene	38	122 ± 54	98 ± 42	T(141)	1000	<15
o-dichlorobenzene	T(189)	<85	<94	T(94)	348	<10
m-dichlorobenzene	T(188)	278 ± 19	557 ± 196	T(94)	<95	<10
p-dichlorobenzene	T(170)	<76	<84	<84	<83	<9

(continued)

Table 15 (cont'd)

	Sample Code					
Chemical	BR-1	BR-2	BR-3	BR-4	BR-5	B
1,2,4-trichlorobenzene	<113	<50	<55	<56	<56	<6
1,3,5-trichlorobenzene	<94	<42	T(55)	<47	<47	<5
1,2,3-trichlorobenzene	<113	<50	<55	<56	<55	<6
vinylidene chloride	<334	<450	<334	<334	<334	<10

[a] See Table A15 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection. Duplicate analyses.

Table 16. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM BATON ROUGE, LA[a]

Chemical	Sample Code[b]				
	BA-1	BA-2	BA-3	BA-4	B
methylene chloride	1229 ± 229	1449 ± 337	1900 ± 900	1000	<5
chloroform	1444 ± 277	1700 ± 233	1417 ± 750	1389	<3
carbon tetrachloride	187 ± 62	T(142)	T(125)	T(125)	<2
vinyl chloride	<15000	<16670	<15000	<15000	<15
1,2-dichloroethylene	<454	<526	<454	<454	<10
1,1-dichloroethane	<380	<444	<380	<380	<8
1,2-dichloroethane	<348	<424	<348	<348	<8
1,1,1-trichloroethane	500 ± 83	2250 ± 1750	T(416)	T(416)	T(5)
1,1,2-trichloroethane	<294	<334	<294	<294	<5
trichloroethylene	T(132)	T(172)	T(132)	<132	<5
tetrachloroethylene	T(59)	T(60)	T(60)	<67	<7
1,1,1,2-tetrachloroethane	<51	<52	<52	<58	<6
1,1,2,2-tetrachloroethane	<51	<52	<52	<58	<6
pentachloroethane	<42	<42	<42	<48	<5
hexachloroethane	<42	<42	<42	<48	<5
chlorobenzene	T(153)	T(128)	<130	<142	<15
o-dichlorobenzene	T(84)	T(85)	T(87)	<95	<10
m-dichlorobenzene	T(102)	T(85)	T(87)	<95	<10
p-dichlorobenzene	<76	<77	<78	<85	<9

(continued)

Table 16 (cont'd)

Chemical	Sample Code				
	BA-1	BA-2	BA-3	BA-4	B
1,2,4-trichlorobenzene	<51	<52	<52	<58	<6
1,3,5-trichlorobenzene	<42	<42	<42	<48	<5
1,2,3-trichlorobenzene	<51	<52	<52	<58	<6
vinylidene chloride	<454	<526	<454	<454	<10

[a] See Table A16 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection. Duplicate analyses.

Table 17. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM HOUSTON, TX[a]

Chemical	Sample Code[b]					
	HO-1	HO-2	HO-3	HO-4	HO-5	B[c]
methylene chloride	T(714)	4555 ± 1555	1222 ± 111	2642 ± 1214	2250 ± 750	<5
chloroform	541 ± 166	2282 ± 162	519 ± 58	896 ± 396	795 ± 147	<3
carbon tetrachloride	T(92)	T(87)	T(87)	T(95)	T(133)	<2
vinyl chloride	<12000	<10,000	<10,000	<12000	<16667	<15
1,2-dichloroethylene	<334	<312	<312	<334	<476	<10
1,1-dichloroethane	<285	<258	<267	<285	<296	<8
1,2-dichloroethane	123 ± 10	157 ± 36	242 ± 0	242 ± 16	345 ± 63	<8
1,1,1-trichloroethane	367 ± 33	235 ± 59	T(470)	T(334)	T(454)	<5
1,1,2-trichloroethane	<250	<227	<227	<250	<312	<5
trichloroethylene	T(100)	T(100)	130 ± 10	T(100)	T(135)	<5
tetrachloroethylene	T(62)	57 ± 4	T(44)	<150	130 ± 26	<7
1,1,1,2-tetrachloroethane	<53	<53	<53	<50	<52	<6
1,1,2,2-tetrachloroethane	<53	<53	<53	<50	<52	<6
pentachloroethane	<43	<43	<43	<40	<43	<5
hexachloroethane	<43	<43	<43	<40	<43	<5
chlorobenzene	<133	T(132)	T(132)	125 ± 0	52	<15
o-dichlorobenzene	<88	T(88)	<88	T(83)	T(86)	<10
m-dichlorobenzene	<88	T(88)	T(88)	T(83)	T(87)	<10
p-dichlorobenzene	<80	<80	<80	<75	<78	<9

(continued)

Table 17 (cont'd)

Chemical	Sample Code					
	HO-1	HO-2	HO-3	HO-4	HO-5	B[c]
1,2,4-trichlorobenzene	<53	<53	<53	<50	<52	<6
1,3,5-trichlorobenzene	<43	T(43)	<43	<40	<43	<5
1,2,3-trichlorobenzene	<53	<53	<53	<50	<52	<6
vinylidene chloride	<334	<312	<312	<334	<476	<10

[a] See Table A17 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection. Duplicate analyses.

[c] Results from four blanks, ng/cartridge.

Table 18. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM UPLAND, CA[a]

Chemical	Sample Code[b]				
	UP-1	UP-2	UP-3	UP-4	B[c]
methylene chloride	27250 ± 17750	42000 ± 32000	1875 ± 125	7750 ± 250	T(5)
chloroform	4423 ± 1346	14730 ± 13115	1269 ± 269	1615 ± 769	T(5)
carbon tetrachloride	T(153)	1461 ± 0	T(154)	T(153)	T(2)
vinyl chloride	<18750	<18750	<18750	<18750	<15
1,2-dichloroethylene	<555	<555	<555	<555	<10
1,1-dichloroethane	<470	<470	<470	<470	<8
1,2-dichloroethane	T(277)	861 ± 140	T(444)	T(444)	<8
1,1,1-trichloroethane	805 ± 528	51721 ± 10055	2344 ± 0	589 ± 410	<5
1,1,2-trichloroethane	<277	<277	<357	<357	<5
trichloroethylene	T(178)	3428 ± 2143	T(178)	T(178)	<5
tetrachloroethylene	1260 ± 458	7259 ± 155	1207 ± 113	70 ± 23	<7
1,1,1,2-tetrachloroethane	<62	<56	<54	<54	<6
1,1,2,2-tetrachloroethane	<62	<56	<54	<54	<6
pentachloroethane	<52	<13	<44	<44	<5
hexachloroethane	<52	<13	<44	<44	<5
chlorobenzene	T(156)	152 ± 12	T(136)	T(136)	<15
o-dichlorobenzene	T(104)	20 ± 9	T(90)	T(90)	<10
m-dichlorobenzene	114 ± 10	382 ± 107	87 ± 22	T(90)	<10
p-dichlorobenzene	<93	<23	<81	<81	<9

(continued)

Table 18 (cont'd)

Chemical	Sample Code				
	UP-1	UP-2	UP-3	UP-4	B[c]
1,2,4-trichlorobenzene	<62	<16	<54	<54	<6
1,3,5-trichlorobenzene	<52	<13	<44	<44	<5
1,2,3-trichlorobenzene	<52	<16	<54	<54	<6
vinylidene chloride	<555	<555	<555	<555	<10

[a] See Table A18 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection. Duplicate analyses.

[c] Average of 4 blanks, ng/cartridge.

Table 19. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM UPLAND, CA[a]

Chemical	Sample Code[b]				
	UP-7	UP-8	UP-9	UP-10	B[c]
methylene chloride	34555 ± 14333	40000 ± 888	44250 ± 22000	37750 ± 12000	≤5
chloroform	885 ± 448	533 ± 199	884 ± 654	423 ± 38	≤3
carbon tetrachloride	T(142)	T(134)	T(153)	T(153)	≤2
vinyl chloride	<16667	<16667	<18750	<18750	<15
1,2-dichloroethylene	<500	T(500)	<555	<555	<10
1,1-dichloroethane	<421	<421	<470	<470	<8
1,2-dichloroethane	T(250)	T(400)	T(444)	T(444)	<8
1,1,1-trichloroethane	616 ± 383	T(454)	944 ± 166	739 ± 204	<5
1,1,2-trichloroethane	<312	<312	<357	<357	<5
trichloroethylene	T(167)	T(167)	T(179)	T(179)	<5
tetrachloroethylene	281 ± 42	89 ± 29	98 ± 42	188 ± 56	<7
1,1,1,2-tetrachloroethane	<62	<16	<51	<56	<6
1,1,2,2-tetrachloroethane	<62	<16	<51	<56	<6
pentachloroethane	<51	<6	<41	<46	<5
hexachloroethane	<51	<6	<41	<46	<5
chlorobenzene	T(156)	T(59)	<127	<139	<15
o-dichlorobenzene	T(104)	T(26)	<84	T(92)	<10
m-dichlorobenzene	T(104)	T(26)	T(84)	T(92)	<10
p-dichlorobenzene	<93	<23	<76	<83	<9

(continued)

Table 19 (cont'd)

Chemical	Sample Code				
	UP-7	UP-8	UP-9	UP-10	B[c]
1,2,4-trichlorobenzene	<61	<16	<51	<56	<6
1,3,5-trichlorobenzene	<51	<6	<41	<46	<5
1,2,3-trichlorobenzene	<61	<16	<51	<56	<6
vinylidene chloride	<500	<500	<555	<555	<10

[a] See Table A19 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection. Duplicate analyses.

[c] Average of 4 blanks, ng/cartridge.

Table 20. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM MAGNA, UT[a]

Chemical	Sample Code[b]					
	B[c]	SA-1	SA-2	SA-3	SA-4	SA-5
methylene chloride	<5	T(714)	23714 ± 13428	6071 +785	2071 +929	5714
chloroform	<3	<123	T(125)	T(125)	T(208)	T(208)
carbon tetrachloride	T(2)	T(95)	166 ± 71	118 ± 23	T(95)	T(95)
vinyl chloride	<15	<12000	<12000	<12000	<12000	<12000
1,2-dichloroethylene	<10	T(334)	<334	T(334)	T(334)	<334
1,1-dichlrooethane	<8	<258	<258	<258	<334	T(334)
1,1,1-trichloroethane	<5	T(334)	T(334)	T(334)	T(334)	T(334)
1,1,2-trichloroethane	<5	<250	<250	<250	<250	<250
trichloroethylene	<5	<100	T(100)	T(100)	T(100)	T(39)
tetrachloroethylene	<7	79 ± 30	80 ± 31	T(54)	T(34)	<69
1,1,1,2-tetrachloroethane	<6	<42	<42	<46	<42	<46
1,1,2,2-tetrachloroethane	<6	<42	<42	<46	<42	<46
pentachloroethane	<5	<32	<32	<36	<32	<36
hexachloroethane	<5	<32	<32	<36	<32	<36
chlorobenzene	<15	T(105)	T(104)	T(115)	T(104)	<115
_o_-dichlorobenzene	<10	T(70)	<69	<77	T(69)	<77
_m_-dichlorobenzene	<10	T(70)	T(69)	T(77)	T(69)	T(77)
_p_-dichlorobenzene	<9	<63	<62	62	62	<69

(continued)

Table 20 (cont'd)

	Sample Code					
Chemical	B	SA-1	SA-2	SA-3	SA-4	SA-5
1,2,4-trichlorobenzene	<6	<42	<42	<46	<42	<46
1,3,5-trichlorobenzene	<5	<32	<32	<36	<32	<36
1,2,3-trichlorobenzene	<6	<42	<42	<46	<42	<46
vinylidene chloride	<16	<334	<334	<334	<334	<334

[a] See Table A20 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicate limits of detection. Duplicate analyses.

[c] Average of 4 blanks, ng/cartridge.

Table 21. ESTIMATED LEVELS OF HALOGENATED ORGANIC VAPORS IN AMBIENT AIR FROM GRAND CANYON, AR[a]

Chemical	Sample Code[b]							
	GC-1	GC-2	GC-3	GC-4	GC-5	GC-6	GC-7	B[c]
carbon tetrachloride	<59	<59	<59	T(59)	T(59)	T(59)	T(59)	≤2
vinyl chloride	<7500	<7500	<7500	<7500	<7500	<7500	<7500	<15
vinylidene chloride	T(260)	<260	T(260)	T(260)	T(260)	T(260)	<260	<10
1,2-dichloroethylene	<260	<260	<260	260	<260	<260	<260	<10
1,1-dichloroethane	<208	<208	<208	<208	<208	<208	<208	<8
1,2-dichloroethane	<208	<208	<208	<208	<208	<208	<208	<8
1,1,1-trichloroethane	218 ± 1	T(217)	T(217)	T(217)	T(217)	T(217)	T(217)	<5
1,1,2-trichloroethane	<167	<167	<167	<167	<167	<167	<167	<5
trichloroethylene	T(130)	T(130)	T(130)	T(130)	<130	T(130)	T(130)	≤5
tetrachloroethylene	<234	<234	T(234)	T(234)	T(234)	T(234)	T(234)	≤7
1,1,1,2-tetrachloroethane	<156	<156	<156	<156	<156	<156	<156	<6
1,1,2,2-tetrachloroethane	<156	<156	<156	<156	<156	<156	<156	<6
pentachloroethane	<130	<130	<130	<130	<130	<130	<130	<5
hexachloroethane	<130	<130	<130	<130	<130	<130	<130	<5
chlorobenzene	<390	<390	<390	<390	<390	T(390)	T(390)	<15
_o_-dichlorobenzene	<260	<260	<260	<260	<260	<260	<260	<10
_m_-dichlorobenzene	T(260)	260	T(260)	T(260)	T(260)	T(260)	T(260)	<10
_p_-dichlorobenzene	<234	<234	<234	<234	<234	<234	<234	<9

(continued)

Table 21 (cont'd)

Chemical	Sample Code[b]							
	GC-1	GC-2	GC-3	GC-4	GC-5	GC-6	GC-7	B[c]
1,2,4-trichlorobenzene	<156	<156	<156	<156	<156	<156	<156	<6
1,3,5-trichlorobenzene	<130	<130	<130	<130	<130	<130	<130	<5
1,2,3-trichlorobenzene	<156	<156	<156	<156	<156	<156	<156	<6

[a] See Table A21 for sampling protocol.

[b] Values in ng/m^3, T = trace, ( ) and < indicates limits of detection. Duplicate analyses.

[c] Average of 4 blanks, ng/cartridge.

Table 22. ESTIMATED LEVELS OF AMBIENT AIR POLLUTANTS IN GEISMAR, LA AREA[a]

Compound	L-12	L-13	L-14A	L-15	L-R1	L-14B	L-16	L-R2	L-S	L-B
nitrobenzene	ND[b]	ND	ND	ND	T	ND	ND	107	ND	ND
2,4-dinitrobenzene	ND	ND	ND	ND	T	ND	ND	27	ND	ND
dinitrobenzene isomer	ND	ND	ND	ND	T	ND	ND	T	ND	ND
diphenylamine	ND	ND	ND	ND	T	ND	ND	T	ND	ND
1,2-dichloroethane	683	ND	10333	7844	232	4689	1555	100	800	1444
carbon tetrachloride	400	1133	1433	300	183	4667	10100	300	286	2633
tetrachloroethylene	46	86	43	86	11	100	36	7	32	100
chloroform	1571	3057	3000	11742	857	9943	999	943	10355	1257
1,1,2-trichloroethane	120	150	5450	9611	ND	6900	ND	ND	320	ND
methylene chloride	1700	1909	727	1714	700	545	772	442	2333	454
1,1,1-trichloroethane	T	250	200	200	75	175	400	ND	80	675
1,2-dichloropropane	ND	1163	ND	121	ND	71	39	3999	ND	36
1,1-dichloroethane	ND	ND	235	75	ND	550	133	ND	ND	167
chlorobenzene	ND	ND	93	93	T	143	171	900	ND	ND
vinylidene chloride	ND	ND	T	ND	ND	200	ND	ND	ND	ND
benzene	287	3712	1562	1363	975	575	261	1212	520	712
benzothiazole	ND	ND	ND	ND	T	ND	ND	T	ND	ND
2,5-diisobutylthiophene	ND	ND	ND	T	ND	ND	ND	ND	ND	ND

[a] See Table A22 and Fig. A14 for sampling protocol and locations, respectively. Values are in ng/m^3.

[b] ND = not detected.

Table 23. VOLATILE ORGANIC VAPORS ESTIMATED IN AMBIENT AIR OF BATON ROUGE, LA AND VICINITY[a]

Chemical	Locations																	
	L17	L18	L19	L20A	L21	L22	L20B	L23	L24	L25A	L26A	L27	L28	L25B	L26B	L29	LE[b]	L30
1,1,1-trichloroethane	178	ND	ND	ND	178	ND	ND	200	178	222	ND	78 ± 24	ND	ND	ND	200	ND	167
1,2-dichloroethane	137	712	458	585	78	ND	887	731	712	10,341	751	322 ± 0	3,229	2,000	1,522	ND	5,024	302
carbon tetrachloride	874	452	289	ND	74	ND	311	592	533	311	533	148 ± 0	429	163	119	74	1,037	192
tetrachloroethylene	84	34	32	ND	60	11	44	53	43	33	64	20 ± 0	364	13	47	17	250	18
chloroform	6,710	6,968	1,290	181	4,775	387	542	1,484	1,097	560	368	568 ± 13	839	387	464	258	2,129	477
dichlorobutane	193	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND
1,2-dichloropropane	ND	ND	ND	ND	ND	ND	ND	30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
vinylidene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-dichloroethane	ND	ND	ND	ND	ND	ND	68	ND	ND	90	ND	ND	ND	34	64	ND	233	ND
1,1,2-trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	80	ND	54	ND	ND	ND	ND	ND	533	ND
hexachloro-1,3-butadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	23	ND	117	ND
chloroprene	ND	ND	ND	ND	x	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
benzene	11,050	2,678	2,535	80	1,220	8,099	9,217	2,132	1,456	676	650	533	2,665	1,248	3,796	273	1,040	1,326
acetone	1,035	1,482	176	729	682	1,521	1,835	2,941	3,294	1,447	988	68 ± 23	729	188	623	329	1,765	329
methylene chloride	2,800	2,160	280	ND	1,999	160	280	840	440	240	160	320 ± 76	200	280	320	160	680	160
β-chlorostyrene	ND	ND	ND	ND	x	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
dichlorobenzene isomer(s)	ND	ND	ND	ND	ND	ND	ND	x	ND	ND	ND	ND	ND	ND	ND	ND	ND	x
chloroprene dimer	ND	ND	ND	ND	x	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	ND	ND
1,1,2,2-tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	T	ND	ND	ND	ND	ND	ND	71

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[a] See Table A23 and Figure A15 and A16, values in ng/m^3.

[b] Downwind of several petroleum facilities.

Table 24. MINIMUM TOTAL HALOGENATED HYDROCARBON VAPOR IN AMBIENT AIR OF BATON ROUGE, LA[a]

Location	ng/m^3	Location	ng/m^3
L17	10,976	L25A	11,797
L18	10,326	L26A	1,925
L19	2,349	L27	1,456
L20A	762	L28	6,517
L21	7,164	L25B	9,407
L22	558	L26B	2,559
L20B	2,132	L29	709
L23	3,930	LE	10,003
L24	3,083	L30	1,387

[a] Concentrations of each halogenated hydrocarbon in previous Table was summed for each location.

Table 25. **CONCENTRATIONS OF AMBIENT AIR POLLUTANTS IN IBERVILLE PARISH, LOUISIANA**[a]

Compound	Locations										
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
1,1,1-trichloroethane	1100±20	1820±100	68±8	1500±20	430±50	2680±0	8760±1160	1556±0	524±61	416±27	112±56
1,2-dichloroethane	1726±345	1219±0	9±7	1590±45	399±28	3727±1127	4709±200	362±4	304±36	146±24	91±30
vinyl chloride	NQ[b]	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
carbon tetrachloride	800±800	ND	20±10	ND	ND	T	4628±1100	335±250	667±200	277±18	ND
dichlorobutane	153±70	2714±2000	71±45	ND	ND	7285±1571	1392±178	ND	54±25	ND	ND
tetrachloroethylene	82±20	977±900	ND	21±0	54±3	489±70	1224±173	159±170	27±3	30±10	16±8
1,1,2,2-tetrachloroethane	52±1	264±191	ND	ND	T	ND	1573±243	ND	148±133	ND	ND
chloroform	1988±122	419±0	ND	633±10	956±112	2433±100	5866±688	1080±468	511±327	1387±161	1113±274
1,2-dichloropropane	944±172	735±37	1015±620	ND	209±4	1363±33	2239±136	T	ND	ND	ND
chloroethane	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
vinylidene chloride	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ	NQ
1,1-dichloroethane	ND[c]	ND	ND	ND	ND	T	478±56	ND	ND	ND	ND
dichloropropene	ND	ND	ND	ND	ND	106±4	261±92	ND	ND	ND	ND
1,1,2-trichloroethane	580±60	ND	ND	ND	36±0	260±18	1840±440	ND	ND	ND	ND
tetrachlorobutadiene	ND	139±70	ND	ND	ND	T	17±11	ND	ND	ND	ND
hexachloro-1,3-butadiene	ND	ND	ND	ND	ND	18±3	37±15	ND	ND	ND	ND
1,3-dichloropropene	10±5	ND	ND	ND	T	ND	ND	ND	ND	ND	ND
trichloropropane	ND	ND	ND	ND	ND	T	24±9	ND	ND	ND	ND
tetrachloropropane isomer	ND	32±30	ND	ND	ND	242±36	13±6	ND	ND	ND	ND
pentachloroethane	ND	ND	ND	ND	T	ND	13±5	ND	ND	ND	ND
bis-(2-chloroisopropyl) ether	66±22	ND	ND	ND	ND	T	363±152	ND	ND	ND	ND
hexachloroethane	ND	ND	ND	ND	ND	T	T	ND	ND	ND	ND
pentachlorobutadiene	ND	ND	ND	ND	ND	ND	T	ND	ND	ND	ND
chlorotoluene	ND	ND	ND	ND	ND	ND	ND	35±7	ND	ND	ND
chlorobenzene	ND	ND	ND	ND	ND	ND	ND	29±10	ND	ND	ND
benzene	1808±163	1727	1990±436	586±23	1423±41	1904±86	1904±86	16077±3714	6181±2480	1668±188	421±71

[a] Values are in ng/m^3 with reproducibility for duplicate cartridges, see Table A24 and Figures A17 and A18 for protocol and locations.

[b] NQ = not quantitated, these compounds were collected and analyzed from carbon cartridges.

[c] ND = not detected.

Table 26. CONCENTRATIONS OF AMBIENT AIR POLLUTANTS IN IBERVILLE PARISH, LA[a]

Compound	Location											
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	B[b]
Chloroacetylene	ND	ND	12	ND	58	ND	45	T	T	ND	ND	ND
Vinyl chloride	192	1,230	30	T	59	534	1,334	64	76	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	1,378	ND	ND	ND	ND	ND
Vinylidene chloride	128	36	ND	ND	ND	132	990	ND	ND	ND	ND	ND

[a] Pollutants which passed through the Tenax GC cartridge were collected on carbon then transferred to Tenax in the lab via thermal desorption, values are in ng/m^3.

[b] B = blank carbon cartridge.

Table 27. AMBIENT AIR LEVELS OF HALOGENATED AND OTHER ORGANICS IN HOUSTON, PASADENA, DEER PARK, FREEPORT AND LA PORTE, TX AREAS

Chemical Class	HL1	HL2	HL3	PL1	PL2	DSL1	PSL2	DDL1	DTL1	DTL2	DTL3	DTL4	FL2	FL3	LL1	LL2	LL3
HALOGENATED HYDROCARBONS																	
2-chloro-1,3-butadiene (chloroprene)	4,000[a]	266	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dichloropropene isomer (tent.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
chloroform	11,539	-	11,538	T	T	53,846	6,420	7,692	1,923	8,846	T	15,384	280	T	8,461	8,850	7,692
vinylidene chloride	-	-	-	-	-	-	-	-	-	-	-	-	-	531	-	-	-
1,1-dichloroethane	-	-	-	-	-	555	-	-	-	-	-	-	-	-	-	-	-
1,2-dichloroethane	T	-	-	-	158	66,300	-	6,722	T	4,055	T	T	3,300	4,500	778	-	-
dibromoethane	-	-	-	158	-	-	-	-	-	-	-	-	-	T	-	-	-
1,1,1-trichloroethane	522	-	900	-	T	-	144	-	-	1,000	400	400	16,600	15,200	3,889	27,700	T
carbon tetrachloride	238	114	T	T	146	846	T	T	T	T	276	69	11,538	T	T	1,230	T
dichloropropane isomer	-	-	-	-	-	T	-	-	-	2,586	-	-	69	1,478	-	-	T
trichloroethylene	75	-	39	76	5,071	321	-	2,535	-	-	-	-	107	200	-	43	T
dichlorobutane isomer	-	700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dichlorobutene isomer	262	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-
1,1,2-trichloroethane	-	-	-	-	-	6,700	-	-	-	3,334	-	-	-	3,821	-	-	-
tetrachloroethylene	29	T	21	20	18	-	T	2,019	75	68	-	72	94	1,585	17	83	T
dichlorobutane isomer	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dichloropropene isomer(s)	-	-	-	-	-	180 90 90	-	-	T,T	241 1,291 72 1,293 345	-	T	-	-	-	-	-
1,1,1,2-tetrachloroethane	-	-	-	-	-	-	-	-	-	-	-	-	-	21	-	-	-
bis-(2-chloroisopropyl)-ether	-	-	-	-	-	-	-	-	-	-	-	-	27	333	-	-	T
hexachloro-1,3-butadiene	-	-	-	-	-	-	-	334	-	2,066	-	25	13.3	8.3	-	T	T
1,2-dibromopropane	-	-	-	-	-	-	-	-	-	-	-	-	-	T	-	-	-
1,1,2,2-tetrachloroethane	-	-	-	-	-	-	-	-	-	19	-	-	-	33	-	-	-
1,2,3-trichloropropane	-	-	-	-	-	-	-	-	-	-	-	-	-	298	-	-	-
pentachloroethane	-	-	-	-	-	-	-	-	-	-	-	-	-	3,984	-	-	-
perchloroethane	-	-	-	-	-	-	-	-	-	-	-	-	-	2,903	-	-	-

(continued)

Table 27 (cont'd)

Chemical Class	HL1	HL2	HL3	PL1	PL2	DSL1	DSL2	DDL1	DTL1	DTL2	DTL3	DTL4	FL2	FL3	LL1	LL2	LL3
tetrachlorobutadiene isomer	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-
pentachlorobutadiene isomer(s)	-	-	-	-	-	-	-	67	-	T	-	-	-	-	-	-	-
vinyl chloride	-	-	-	-	-	-	-	T	-	100	-	-	-	-	-	-	-
trichloropropene isomer(s)	-	-	-	-	-	-	-	-	-	T,T	-	-	-	-	-	-	-
OXYGENATED COMPOUNDS																	
1-butyl isobutyrate	T	1,233	-	-	?	-	T	-	-	33	T	-	-	-	-	-	T
2-butyl-n-butyrate	330	-	-	-	-	-	-	-	-	-	-	-	1,291	1,586	-	1,334	2,066
n-butyl-n-butyrate	-	600	-	-	-	-	T	230	-	-	T	670	1,435	1,010	3,334	7,300	4,167
dimethyl phthalate	T	-	-	-	-	-	-	-	-	T	-	T	-	-	100	-	-
diethyl phthalate	-	113	-	T	-	134	T	-	-	-	T	330	-	-	500	1,000	-
amyl benzoate	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dibutyl phthalate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	567	-	-
amyl benzoate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
dibutyl phthalate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
methyl methacrylate	-	-	-	-	-	-	-	547	T	-	-	-	-	-	-	-	-
isobutyl methacrylate	-	-	-	-	-	-	-	333	1,334	-67	-	-	-	-	-	-	-
n-butyl methacrylate	-	-	-	-	-	-	-	-	2,380	-	-	-	-	-	-	-	-
sec-butyl acrylate	-	-	-	-	-	-	-	167	-	-	-	-	-	-	-	-	-
n-butyl acrylate	-	-	-	-	-	-	-	2,670	-	-	-	-	-	-	-	-	-
n-hexyl acrylate	-	-	-	-	-	-	-	3,000	-	-	-	-	-	-	-	-	-

[a]Values are in ng/m^3, see Table A25 and Figure A19 and A21 for protocols and locations.

Table 28. AMBIENT AIR LEVELS OF SEVERAL VOLATILE ORGANIC VAPORS SURROUNDING AMERICAN CYANAMID CORP., LINDEN, NJ[a]

Chemical Class	Compound	P1/L1	P1/L2	P1/L3	P1/L4	P2/L1	P2/L2	P2/L3	P2/L4	P3/L1	P3/L2	P3/L3	P3/L4
Halogenated Hydrocarbon	methylene chloride	100	258	168	58	52	324	369	134	81	261	972	418
	chloroform	50	154	133	99	41	195	178	150	86	229	773	190
	1,2-dichloroethane	-	14	9	42	12	9	47	34	T	38	9	8
	1,1,1-trichloroethane	13	735	9	13	9	13	39	244	T	3,116	1,440	24
	carbon tetrachloride	21	22	28	10	14	14	71	51	T	32	T	T
	trichloroethylene	-	139	11	6	8	2	242	25	-	17	T	T
	chlorobenzene	3	15	123	272	11	4	30	222	-	T	T	T
	o-dichlorobenzene	2	-	-	-	-	-	-	74	-	20	-	T
	dichlorobenzene isomer	T	30	-	1	-	-	13	T	-	T	T	T
	trichlorobenzene isomer	-	2	-	-	-	-	7	T	-	T	-	T
Sulfur Compounds	2-thiopropane	-	T	T	-	-	-	-	-	-	-	-	-
	2,3-dithiabutane	-	T	-	T	-	T	T	-	-	-	-	T
	dithiapentane isomer	-	-	-	-	-	-	T	-	-	-	-	T
	3,4-dithiahexane	-	-	-	-	-	-	T	-	-	-	-	T
Aromatics	benzene	490	890	1,342	613	174	43	21,309	8,239	224	223	1,226	1,342
	cyanobenzene	-	23	49	8	14	-	18	T	T	T	T	T
Oxygenated Compounds	furan	20	18	46	9	23	-	-	-	-	-	-	-
	t-butanol	1,745	160	129	87	202	-	247	219	-	-	-	-
	isopropanol	-	25	4	4	59	-	-	-	-	-	-	-
	methyl ethyl ketone	30	45	69	40	84	-	T	T	T	-	-	T
	benzaldehyde	119	127	164	36	83	-	557	344	-	136	328	158
	acetophenone	173	232	251	131	205	-	1,167	459	-	322	300	241
	methyl vinyl ketone	15	19	10	45	-	-	16	-	-	-	-	-
	cyclohexanone	158	-	-	22	-	-	629	-	-	-	-	T
	anisole	-	-	4.4	-	-	-	T	T	-	-	-	T
	diethyl maleate	-	-	-	-	-	-	-	1,085	83	60	T	447
	diethyl fumarate	-	488	882	863	40	-	251	586	T	62	T	406
	tolualdehyde	87	31	54	17	61	-	83	T	T	T	T	T

[a] See Table A26 and Figure A22 for protocol and locations, values in ng/m^3.

Table 29. AMBIENT AIR LEVELS OF SEVERAL VOLATILE ORGANIC VAPORS SURROUNDING E. I. DuPONT deNEMOURS, DEEPWATER, NJ

Chemical Class	Compound	P4/L5	P4/L6	P4/L7	P4/L8	P5/L5	P5/L6	P5/L7	P5/L8	P6/L5	P6/L6	P6/L7	P6/L8	Tenax Blank
Halogenated Hydrocarbons	methylene chloride	65	405	35	437	75	486	-	625	345	248	261	81	T
	chloroform	152	-	-	T	150	439	-	64	-	70	90	13	T
	1,2-dichloroethane	12	-	-	T	-	-	-	53	-	-	-	24	-
	1,1,1-trichloroethane	-	-	2,842	T	-	-	-	67	-	-	-	14	-
	carbon tetrachloride	19	-	-	-	-	-	-	-	-	-	-	32	-
	trichloroethylene	4	-	-	-	-	-	-	56	-	-	-	5	-
	1,2-dibromoethane	-	-	T	-	-	-	-	-	-	-	-	-	-
	tetrachloroethylene	6	13	T	60	69	-	-	218	22	29	-	57	-
	chlorobenzene	14	15	11	512	55	-	-	305	25	17	12	669	-
	o-dichlorobenzene	17	554	-	51	25	-	-	-	T	-	-	1,319	-
	dichlorobenzene isomer	19	12	-	1,240	21	-	-	T	101	404	-	14	-
	trichlorobenzene isomer	T	T	-	136	-	-	-	150	13	-	-	113	-
	dichloroethylene	-	-	-	-	-	-	-	-	-	-	-	-	-
	dichlorotoluene	-	-	-	59	-	-	-	61	-	107	-	29	-
Sulfur	2,3-benzothiophene	-	-	-	T	-	-	-	-	-	536	-	T	-
	methylbenzothiophene	-	-	-	-	-	-	-	-	-	116	-	T	-
Oxygenated Compounds	furan	T	-	-	-	-	-	-	-	59	-	-	-	-
	acetone	T	-	-	-	-	-	-	-	-	-	-	-	-
	methyl ethyl ketone	T	-	-	-	-	-	-	-	-	-	-	-	-
	methyl vinyl ketone	T	-	-	-	-	-	-	-	72	-	-	-	-
	methyl methacrylate	-	-	-	25	-	-	95	27	-	21	-	16	-
	dibenzofuran	-	184	-	-	-	138	-	29	-	3,279	-	-	-
	phenylacetladehyde	-	28	33	-	-	-	-	-	-	41	T	-	-
Nitrogen Compounds	cyanobenzene	T	-	12	21	35	-	-	-	-	-	-	-	-
	aniline (or methylpyridine)	-	-	-	28	-	-	-	-	-	-	-	-	-
	nitrobenzene	-	-	-	123	-	-	-	-	-	-	-	105	-
	chloroaniline isomer	-	-	-	146	-	-	-	-	-	5,960	-	T	-
	nitrophenol	-	-	-	73	-	-	-	-	-	-	-	24	-
	o-nitrotoluene	-	-	-	T	-	-	-	-	-	47	-	-	-
	p-nitrotoluene	-	-	-	59	-	-	-	86	-	-	-	-	-

(continued)

Table 29 (cont'd)

Chemical Class	Compound	P4/L5	P4/L6	P4/L7	P4/L8	P5/L5	P5/L6	P5/L7	P5/L8	P6/L5	P6/L6	P6/L7	P6/L8	Tenax Blank
	chloronitrobenzene isomer (or chloroaniline)	-	-	-	360	-	-	-	T	-	-	-	-	-
	dichloronitrobenzene (or dichloroaniline)	-	-	-	2,704	-	-	-	T	-	-	-	32	-
	quinoline	-	41	-	-	-	-	-	-	-	-	-	-	-
	methylquinoline	-	-	-	-	-	-	-	-	-	1,478	-	-	-

[a] See Table 18 and Figures A23 and A24 for protocol and locations, values in ng/m³.

Table 30. RECOVERIES OF SELECTED ORGANIC VAPORS FROM TENAX CARTRIDGES SUBJECTED TO SAMPLE TRANSPORTATION AND STORAGE[a]

Trip No.	Chemical	Quantity Added (ng)	Quantity Observed (ng)	% Recovery
1	methylene chloride	325	260	80
	chloroform	197	108	55
	1,1,1-trichloroethane	35	24	69
	benzene	249	234	93
	toluene	112	117	104
2	methylene chloride	300	218	72
	chloroform	200	109	55
	1,1,1-trichloroethane	35	20	57
	benzene	241	268	111
	toluene	110	77	70

[a] Consisted as part of Kanawha Valley (Tables A7, A8) and Shenandoah Valley (A11, A12) studies.

4.0 References

1. E. D. Pellizzari. "The Measurement of Carcinogenic Vapors in Ambient Atmospheres", Publication No. EPA-600/7-77-065, Contract No. 68-02-1228, June, 1977.

2. E. D. Pellizzari. "Analysis of Organic Air Pollutants by Gas Chromatography and Mass Spectroscopy", Publication No. EPA-600/2-77-100, Contract No. 68-02-2262, June, 1977.

3. E. D. Pellizzari. "Measurement of Carcinogenic Vapors in Ambient Atmospheres", Contract No. 68-02-1228, Final Report, 1978 in preparation.

5.0 Acknowledgements

The collection and instrumental analysis of ambient air samples was supported by EPA Contract Nos. 68-02-1228, 68-02-2262, 68-01-1978, 68-02-2543, 68-02-2721, 68-02-2808, and 68-02-2764.

APPENDIX A

SAMPLING PROTOCOLS AND LOCATIONS OF STUDY SITES

Table A1. SAMPLING PROTOCOL FOR KIN-BUC DISPOSAL SITE

					Meteorological Conditions			
Period	Location	Distance from Site[a]	Sampling Time	Sampling Volume[b]	T(°F)	%RH	Wind Dir./ Speed	in Hg
6/29/76 (P1)	L1 (Tower Marina)	255°/1.65 km	1207-1359	112.5	82	69	255°/2-7 mph	30.19
	12 (Meadow Rd.)	~345°/0.4 km	1206-1355	134	82	69	240°/3-7 mph	30.19
	L3 (N of Site)	25°/0.41 km	1207-1359	156	82	69	240°/3-7 mph	30.19
	L4 (N of Site)	35°/0.29 km	1207-1359	140	82	69	210-255°/ 2-8 mph	30.19
(P2)	L1 (Tower Marina)	255°/1.65 km	1607-1737	111.4	86	57	270°/2-7 mph	30.18
	L2 (Meadow Rd.)	~345°/0.36 km	1607-1737	175	86	57	220-240°/ 0-3 mph	30.18
	L3 (E of Site)	40°/0.18 km	1607-1737	183.4	86	57	-	30.18
	L4 (E of Site)	35°/0.22 km	1607-1737	187.2	86	57	245°/0-2 mph	30.18
6/30/76 (P3)	L1 (Sayreville)	2.01 km ESE from site	1029-1229	138.5	82	76	70°/2-7 mph	30.12
	L2 (Meadow Rd.)	45 m downwind of chemical plant	1030-1230	187.5	82	76	100→140°/ 2-7 mph	30.12
	L3 (Meadow Rd.)	350°/0.46 km	1029-1229	175.9	82	76	-	30.12
	L4 (W of Site)	305°/0.34 km	1029-1229	191.2	82	76	95→120°/ 5-9 mph	30.12

(continued)

Table A1 (cont'd)

Period	Location	Distance from Site[a]	Sampling Time	Sampling Volume[b]	Meteorological Conditions			
					T (°F)	%RH	Wind Dir./ Speed	in Hg
(P4)	L1 (Tower Marina)	255°/1.65 km	1457-1646	117.7	88	57	180→200°/ 5-12, 20-35, 10-20	30.07
	L2 (Meadow Rd.)	21 m from chemical plant	1458-1646	248	88	57	190°/5-15 mph	30.07
	L3 (N of Site)	0°/0.73	1457-1646	200.3	88	57	190°/5-20 mph	30.07
	L4 (NE, then N of site)[c]	25°/0.41 km 345°/0.91 km	1457-1528 1537-1648	0.104 0.269	88	57	180→200°/ 5-35 mph	30.07
7/1/76 (P5)	L1 (Tower Marina)	255°/1.65 km	1006-1206	114.4	79	57	270°/5-9 mph	30.10
	L2 (Meadow Rd.)	~76 m from chemical plant	1006-1206	204.2	79	57	230-260°/ 4-12 mph	30.10
	L3 (On-Site)	-	1015-1038	19.8	79	57	260°/4-9 mph	30.10
	L4 (E of Site)	40°/0.18 km	1006-1206	230	79	57	230-250°/ 4-12 mph	30.10
(P6)	L1 (Tower Marina)	255°/1.65 km	1425-1625	120	84	43	270°/2-5 mph	30.12
	L2 (Meadow Rd.)	345°/0.36 km	1425-1625	181	84	43	230-260°/ 2-5 mph	30.12
	L3 (On-Site)	-	1444-1458	19.8	84	43	230-260°/ 2-5 mph	30.12

(continued)

Table A1 (cont'd)

					Meteorological Conditions			
Period	Location	Distance from Site[a]	Sampling Time	Sampling Volume[b]	T(°F)	%RH	Wind Dir./ Speed	in Hg
	L4 (E of Site)	40°/0.18 km	1425-1625	208.4	84	43	230-260°/ 2-8 mph	30.12

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[a] Approximate magnetic bearing and distances relative to Kin-Buc.

[b] Volume in liters.

[c] Sampler was moved to new site during sampling period.

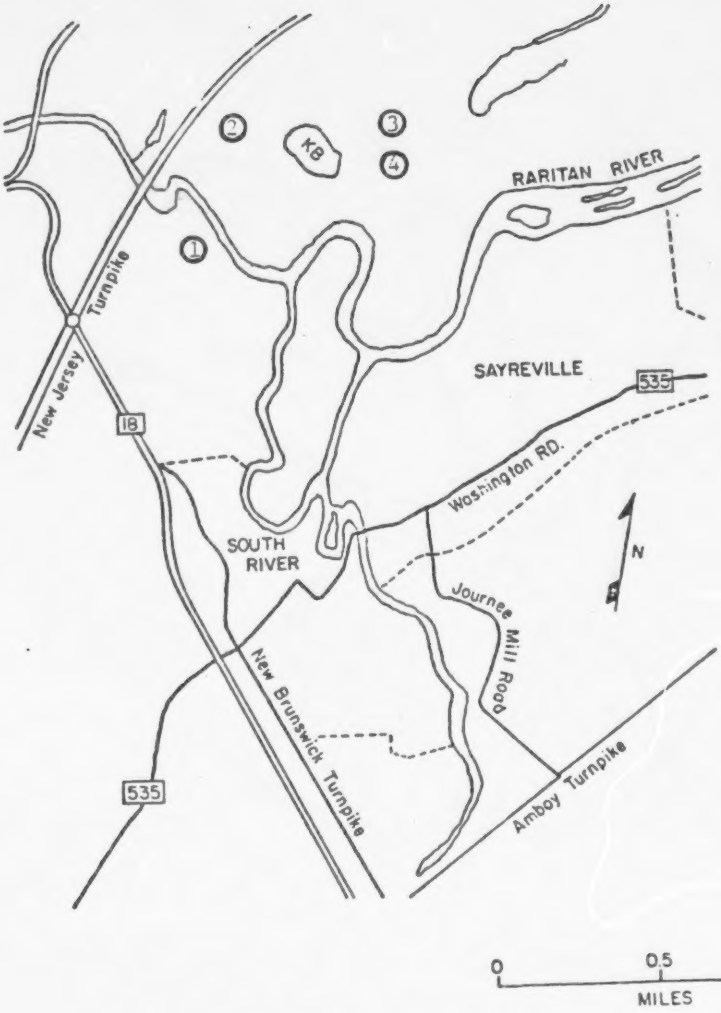

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Figure A1. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ (P1).

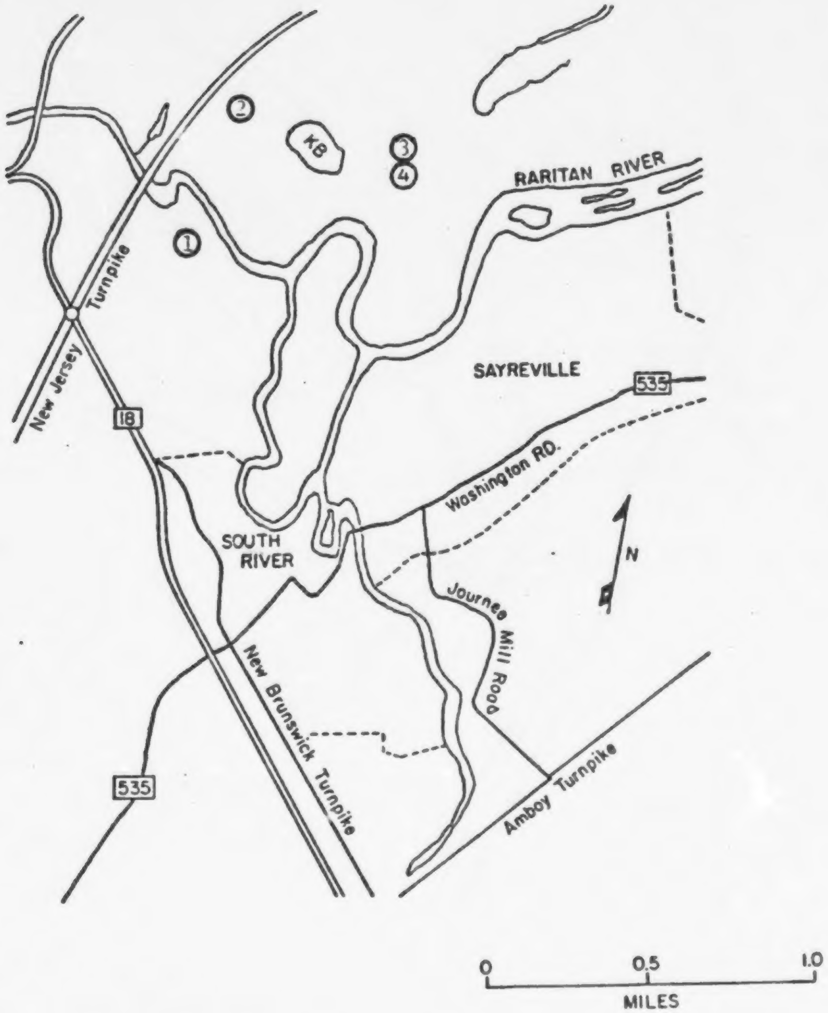
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Figure A2. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ (P2).

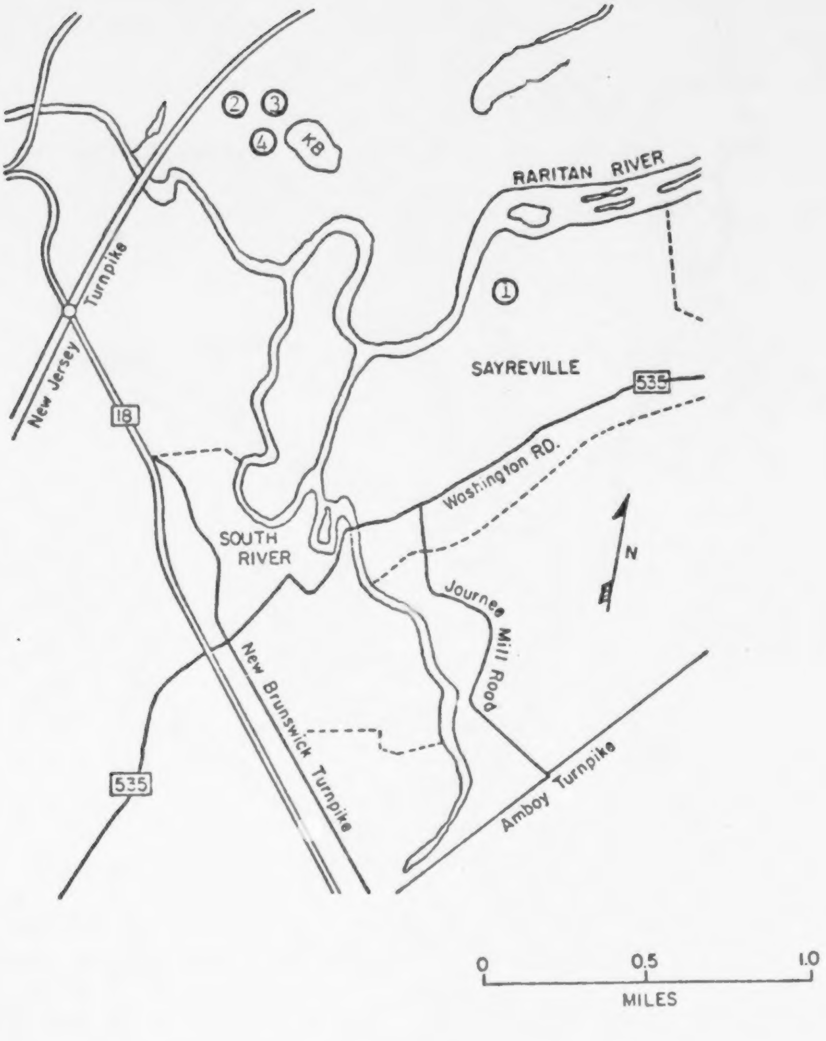
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Figure A3. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ (P3).

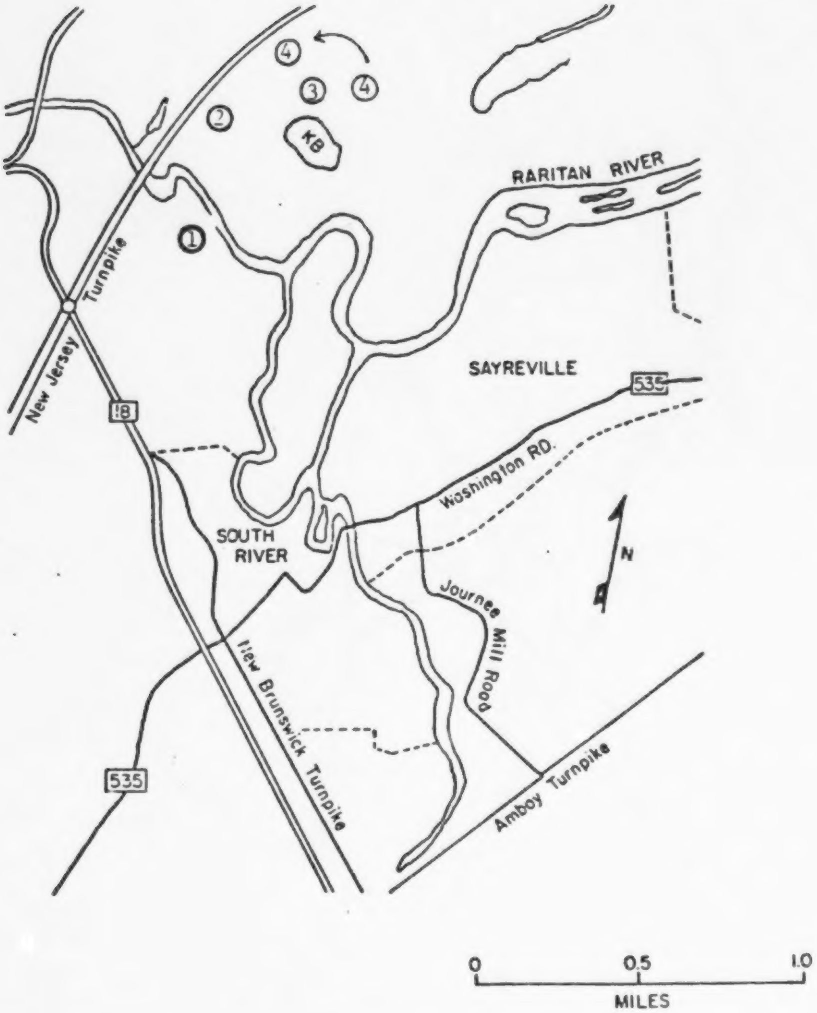
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Figure A4. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ (P4).

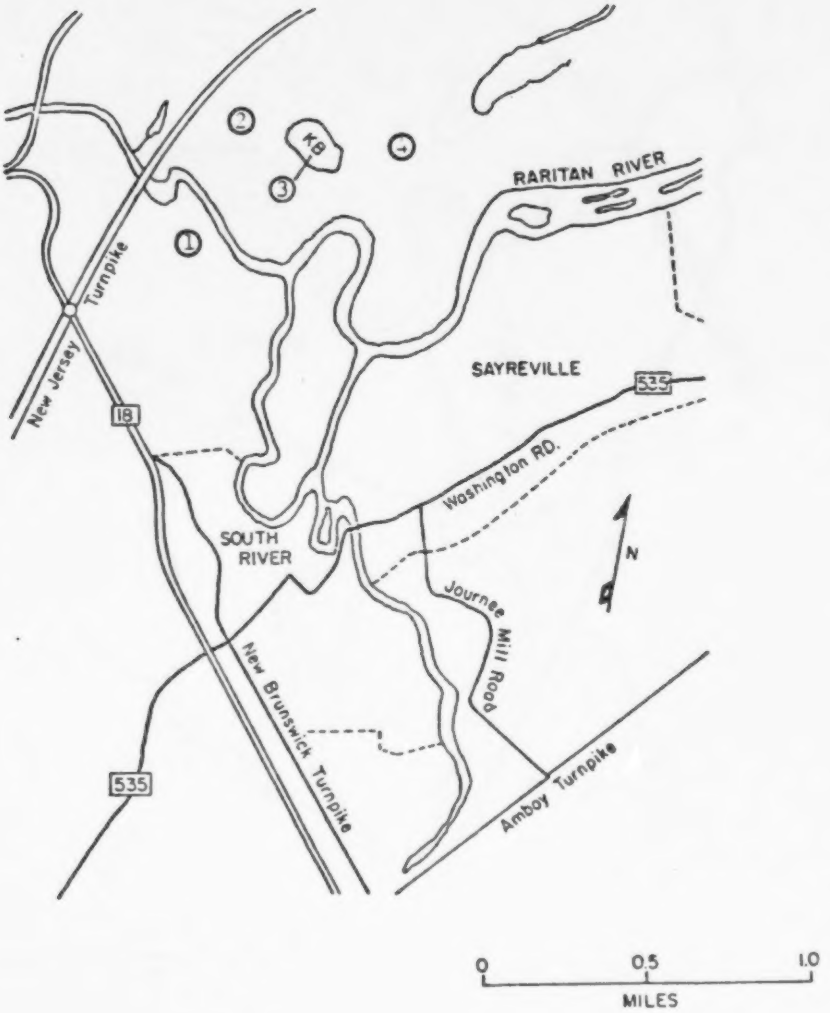
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Figure A5. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ (P5).

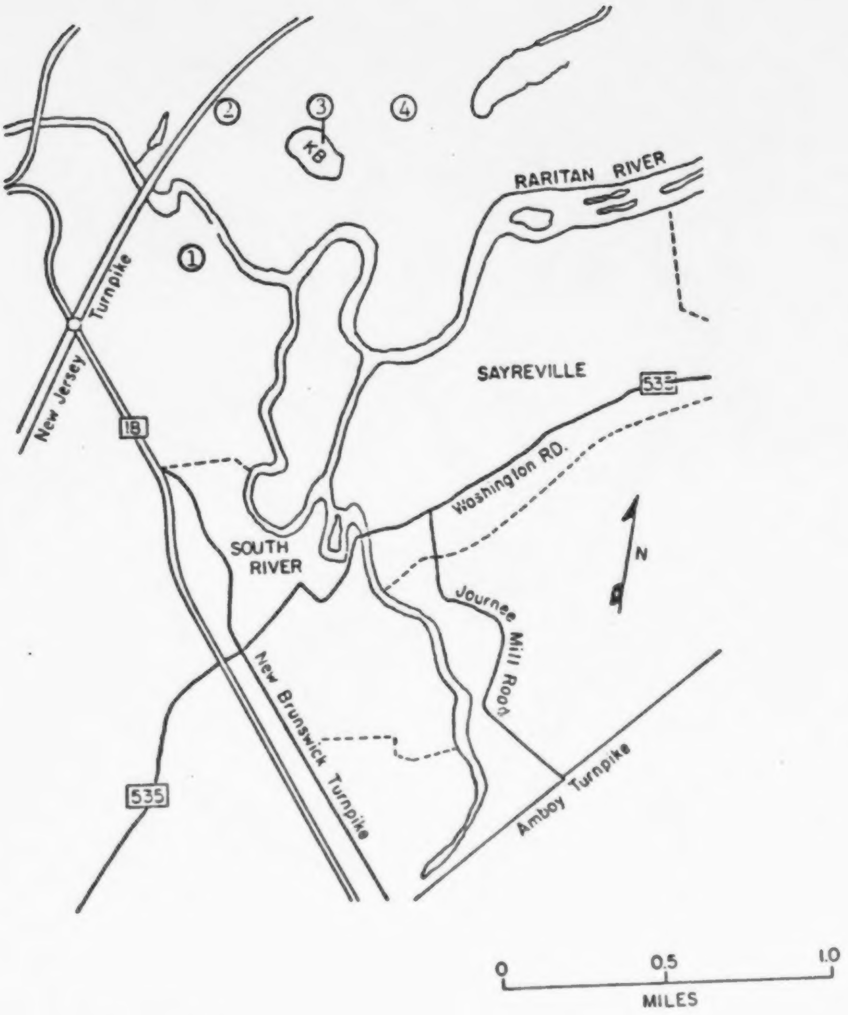
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Figure A6. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ (P6).

Table A2. AMBIENT AIR SAMPLING PROTOCOL FOR INVESTIGATING CHEMICAL DUMP/LANDFILL IN EDISON, NJ

Sampling Period	Location (No.)[a]	Bearing°/distance[b] (mi)	Sampling Time (min)	m^3/cartridge	Remarks
1	Parkland (1)	180-260/0.25	36	0.317	3/24/76 - 12:47 pm-1:23 pm 65°F 35% RH Clear 30.48" Hg Wind ∿230°, 3-8 mph
2	Tower Marina (2) Schoolhouse Rd. East Brunswick, NJ	065-909/∿1	38	0.300	3/24/76 - 4:47 pm-5:25 pm 64°F 38% RH Clear 30.42" Hg Wind 200-230°, 5-13 mph (upwind sample)
	Parkland (1)	180-260/0.25	38	0.290 0.032	As above (downwind samples)
3	Tower Marina (2)	065-090/∿1	40	0.300	3/25/76 - 11:15 am-11:55 am 60°F 43% RH 3/4 Cloud 30.22" Hg Wind 225°, 3-8 mph (upwind sample)
	Parkland (1)	180-260/0.25	39	0.300	As above (downwind sample)
4	Tower Marina (2)	065-090/∿1	45	0.300	3/25/76 - 3:08 pm-3:53 pm As above (upwind sample)
	Parkland (1)	160-275/∿0.06	41	0.300	3/25/76 - 3:05 pm-3:46 pm As above (downwind sample)

(continued)

Table A2 (cont'd)

Sampling Period	Location (No.)[a]	Bearing°/distance[b] (mi)	Sampling Time (min)	m^3/cartridge	Remarks
	Top of KB Mound	--	11	0.060 0.060	3/2576 - 3:06 pm-3:17 pm 64°F 38% RH Overcast 30.11" Hg Wind 265-285°, 5-10 mph
	Meadow Rd. (5) (between Stauffer and KB)	145°/0.5	42	0.300	3/25/76 - 4:20 pm-5:02 pm 63°F 45% RH 9/10 Cloudy 30.14" Hg Wind 245°, 2-8 mph (upwind sample)
5	NJ Turnpike (3) at Mill Rd.	140°/~0.75	130	0.914	3/26/76 - 10:48 am-12:59 pm 60°F 34% RH Clear 30.41" Hg Wind 300-320°, 0-10 mph Shifting to 230° at 12:45 pm (upfield sample)
	Sayreville, NJ (4) at St. Stanislaus School Rd.	315-325/1.25	130	0.958 0.117	3/26/76 - 10:49 am-12:59 pm As above (downwind sample)

[a] See map (Fig. A7) for location number.

[b] Relative to dump site.

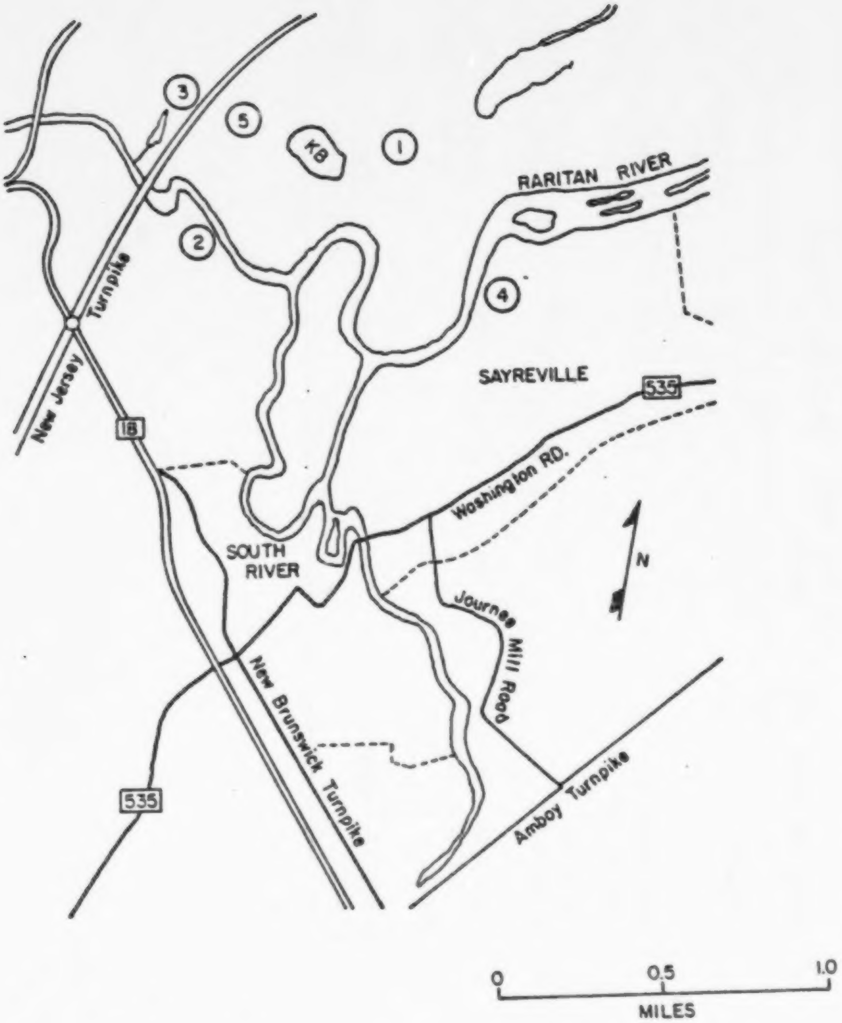
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Figure A7. Sampling locations surrounding Kin-Buc Land-fill, Edison, NJ

Table A3. SAMPLING PROTOCOL FOR CENTRAL AND NORTHERN NEW JERSEY

Site	Sampling Location	Sampling Time (min)	Sampling Volume (ℓ)	Remarks
Paterson, NJ (S1)	12th St. & 4th Ave.	42	300	3/22/76 1231-1313 hr 40°F 300-360°/3 mph
Clifton, NJ (S2)	Dyer Ave. & Wheeler St.	39	300	3/22/76 1528-1607 hr 45°F 320°/2 mph
Passaic, NJ (S3)	First St. & Essex St.	39	300	3/22/76 1715-1754 hr 40°F 320°/5 mph
Hoboken, NJ (S4)	New County Rd. U. S. Post Office Depot	39	300	3/23/76 1223-1302 hr 51°F 280°/0-10 mph
Fords, NJ (S8)	North of Tenneco plant	44	300	3/26/76 1559-1643 hr 72°F 200°/0-2 mph

Table A4. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN TULSA, OK

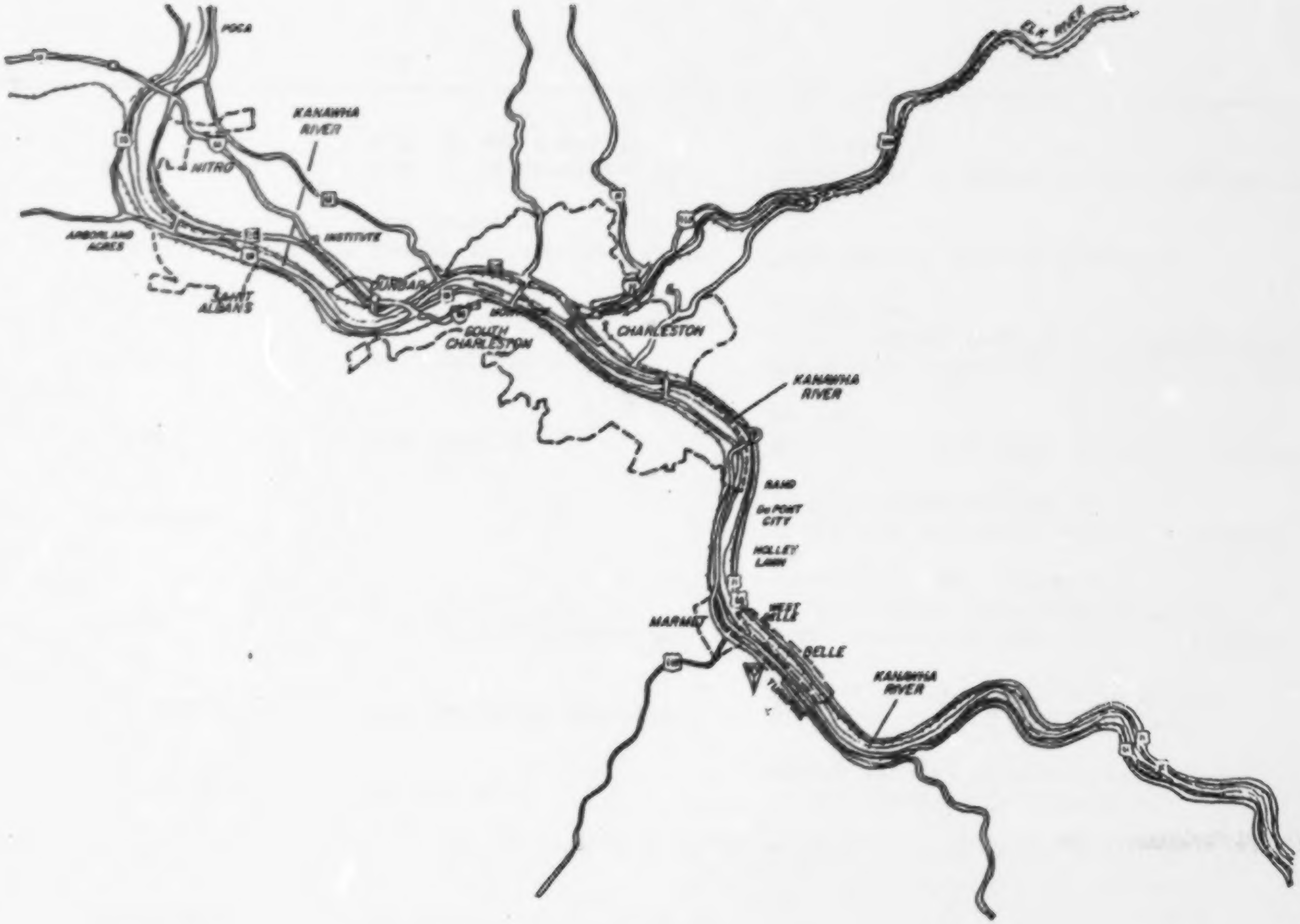
Sampling Site	Location	Code	Date	Period	Volume Sampled (ℓ)	Remarks
Liberty Mounds	District Water Works	LM1	7/10-11/77	0355-0355 hrs	160.8	72°F → 93 → 81°F 0 kts 77% RH
Downtown Tulsa, OK	Post Office Garage Lot (2nd & Elwood)	DT1	7/11-12/77	0600-0600 hrs	142.5	80°F → 97 → 83°F 0 kts 77% RH
Liberty Mounds	District Water Works	LM2	9/21/77	0600-0900 hrs	351	67°F → 71°F 5-7 kts/180 → 210°
Downtown Tulsa, OK	Post Office Garage Lot (2nd & Elwood)	DT2	9/21/77	0600-0900 hrs	390	67°F → 71°F 5-7 kts/180-210°
Vera		V1	9/21/77	1400-1700 hrs	390	93°F → 82°F 5-7 kts/180-210°

Table A5. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN HOUSTON, TX

Sampling Site	Location	Code	Date	Period	Volume Sampled (ℓ)	Ambient Temp. (°F)
Texas Air Control	Aldine (Mail Rt.)	TC1	6/22/77	0945-1245 hrs	90.5	90
Houston Air Pollution Control	Clanton Dr.	HC1	6/28/77	0745-1050 hrs	65.7	80
Houston Air Pollution Control	Clanton Dr.	HC2	7/19/77	0630-0930 hrs	63.2	80
Texas Air Control	Aldine (Mail Rt.)	TC2	7/20/77	0630-0930 hrs	57.3	80
Houston Air Pollution Control	Crawford at Polk	HC3	10/19/77	0615-0915 hrs	113.4	68
Texas Air Control	Aldine (Mail Rt.)	TC3	10/20/77	1207-1510 hrs	89.3	74
Houston Air Pollution Control	Crawford at Polk	HC4	10/21/77	1546-1853 hrs	66.8	70
Houston Air Pollution Control	Clanton Dr.	HC5	10/21/77	0607-0907 hrs	108.4	72

Table A6. SAMPLING LOCATIONS IN THE KANAWHA VALLEY, WV

Location	Site	Address	Remarks
L1	Charleston	4th Ave. W. and 21st St. W.	North Charleston Recreation Center. [MAS located at Maintenance Steel near west entrance; MRI and duPont samples located around swimming pool.
L2	S. Charleston	314 4th Ave.	S. Charleston Fire Department Sample located on upper level roof.
L3	St. Albans	6500 MacCorkle Ave. S.W.	Riverside Nursing Home. Sampler located on river bank in open area.
L4	Nitro	N.W. of intersection of W.V. 25 and I-64.	Nitro Sewage Treatment Plant. Sampler located along fence, upwind of all sewage treatment facilities.
L5	W. Belle		Marmet Dam and Locks. Sampler located on hill above parking lot.
L6	Nitro	2009 20th St.	Nitro Fire Department. Sampler located on roof.
L7	Nitro	4107 1st Ave.	Front yard of private residence, directly across street from chemical manufacturing facilities.
L8	Institute	Barron Dr. between 4th St. and Curtis Sq.	Back yard of private residence.
L9	Nitro	N.W. of intersection of W.V. 25 and I-64.	South side of United Distribution Service parking lot.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BELLE
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Figure A8. Map of Kanawha Valley, WV

Table A7. SAMPLING PROTOCOL FOR KANAWHA VALLEY, WV

Site	Period/Location	Sampling Time	Sampling Volume (ℓ)	Remarks*
Charleston	P1/L1	1030-1435 (9/27 - 9/28)	29,500,000[a]	T[b] = 7°C to 20°C. Winds: S.S.W. to W./calm to 2.8 m/s.
Charleston	P1/L1	1020-1435 (9/27 - 9/28)	258[c]	At 0955 (9-27), RH[d] = 85%, T = 19°C, low cloud cover.
S. Charleston	P1/L2	1115-1617	597	T = 22°C, RH = 72%, low cloud cover.
St. Albans	P1/L3	1202-1715	557	T = 17°C to 20°C. Winds: S.S.W. to W.S.W./1.4 to 28 m/s. Rain for 1 hour.
Nitro	P1/L4	1400-1610	497	T = 18°C to 20°C. Winds: S.W./1.7 to 2.8 m/s.
W. Belle	P1/L5	1349-1945	564	T = 18°C to 20°C. Winds: S.W./1.7 to 2.8 m/s.
S. Charleston	P2/L2	0825-1308	558	T = 8°C to 13°C. Winds: W. to S.W./0.5 to 1.7 m/s.
St. Albans	P2/L3	0715-1355	710	T = 8°C to 15°C. Winds: W. to S.W./calm to 1.7 m/s.
W. Belle	P2/L5	0740-1555	541	T = 7°C to 20°C. Winds: W. to S.W./0.5 to 1.7 m/s.
Nitro	P2/L6	0930-1320	410	T = 9°C to 13°C. Winds: W. to S.W./1.1 to 1.7 m/s; overcast.

[a] Sample collected with MAS

[b] Temperature

[c] Long-term samples taken with small duPont personal sampling pump.

[d] Relative humidity

*General weather conditions for 9/27 and 9/28: Cool, skies overcast with periods of intermittent light rain and slow but steady showers. Winds: calm to light breezes.

Table A8. SAMPLING PROTOCOL FOR KANAWHA VALLEY, WV

Site	Period/Location	Sampling Time	Sampling Volume ( )	Remarks*
Charleston	P1/L1	0910–0820 (10/24–10/26)	49,700,000^{a}	T^{b} = 7°C to 23°C, RH^{c} = 31% to 91%. Wind: E.S.E./calm to 7 m/s.
Charleston	P1/L1	0925–0850 (10/24–10/26)	512^{d}	At 0910 (10-24), T = 10.5°C, RH = 87%, partly cloudy. Eight hours of light rain during sampling time T = 13°C to 22°C^{f}, RH = 35% to 93%^{f}. Winds: E.S.E. to E.^{f}/calm to 6 m/s^{f}.
S. Charleston	P1/L2	1200–1737	268	T = 23°C to 18°C. Winds: S. to E.S.E./1.1 to 5 m/s. At 1151, T = 23°C, RH = 32%, slightly hazy, no odors.
St. Albans	P1/L3	1130–1635	370	T = 17°C to 23°C. Winds: S.S.W. to E.S.E./1.1 to 5 m/s. At 1125, T = 17°C, RH = 54%, low haze, no odors.
Nitro	P1/L4	1035–1600	322	T = 17°C to 23°C. Winds: S.S.W. to E.S.E./1.1 to 5 m/s. At 1030, T = 17°C, RH = 68%; hazy, strong odor.
W. Belle	P1/L5	1315–1808	414	T = 23°C to 17°C. Winds: S.S.W. to E.S.E./1.1 to 5 m/s. At 1313, T = 23°C, RH = 50%; hazy, slight odor.
S. Charleston	P2/L2	0632–1205	297	T = 14°C to 18°C. Winds: E. to S.E./calm to 4 m/s. RH = 58% to 69%.
St. Albans	P2/L3	0534–1147	432	T = 14°C to 18°C. Winds: E. to S.E./calm to 4 m/s. At 0533, T = 14°C, RH = 88%; overcast, strong odor. RH = 55% to 72%^{f}.
Nitro	P2/L4	0505–1118	410	T = 14°C to 17°C. RH = 55% to 72%^{f}. Winds: E. to S.E./calm to 4 m/s. Overcast, strong odor. At 0505, T = 18°C^{e}, RH = 79%.
W. Belle	P2/L5	0600–1235	569	T = 13°C to 18°C. RH = 55% to 72%^{f}. Winds: E. to S.E./calm to 4 m/s. At 0555, T = 13°C. Overcast, no odor. RH = 69% to 54%.

[a] Sample collected with MAS.
[b] Temperature.
[c] Relative humidity.
[d] Long-term sample collected with duPont personal sampling pump.
[e] Temperature beside sewage treatment plant settling ponds -- somewhat higher than ambient.
[f] Data from National Weather Service Forecast Office, Kanawha Airport, Charleston, WV.

*General weather conditions for 10/24 through 10/26: Cool, skies clear with low-lying haze changing to overcast with some light shower activity. Winds generally calm to moderate from the S.E. to S.W

Table A9. SAMPLING PROTOCOL FOR KANAWHA VALLEY, WV

Site	Period/Location	Sampling Time	Sampling Volume (ℓ)	Remarks*
Charleston	P1/L1	1910-0917 (11/16-11/20)	90,800,000^{a}	Odors: occasionally strong chemical. At 1005 (11-17) RH^{e} = 63%. At 1125 (11-18) RH = 38%. T^{c} = 2 to 15°C^{f}, RH = 28% to 100%^{f}. Winds: S.W. to N. to E.^{f}/calm to 11 m/s.^{f}
Charleston	P1/L1	1910-1125 (11/16-11/18)	344^{b}	T = 4°C to 15°C^{f}, RH = 31%-80%^{f}. Winds: S. to W./2-11 m/s^{f}.
S. Charleston	P2/L2	1235-1737	1087	T = 11°C to 9°C. Wind: W.S.W./6 to 10 m/s. RH= 31% to 44%.^{f}
W. Belle	P2/L5	1348-1811	1205	T = 11°C to 9°C. Wind: W.S.W./4 to 10 m/s. RH= 31% to 44%.^{f}
Nitro	P2/L7	1335-1725	480^{d}	T = 11°C to 10°C. Wind: W.S.W./4 to 10 m/s. At 1335 and 1720, odor strong. RH = 31% to 44%^{f}.
Institute	P2/L8	1235-1700	861	T = 11°C to 10°C. Wind: S.W.S./6 to 10 m/s. At 1235 and 1700, odor acrid, of rotting walnuts. RH=31% to 44%^{f}.
Charleston	P3/L1	1135-0930 (11/18-11/20)	331^{b}	At 1125 (11-18), T = 10°C, RH^{e} = 38%, sky clear. T= 1°C to 15°C^{f}, RH=28% to 100%^{f}. Wind: S.W. to N.to E.^{f}/calm to 6 m/s^{f}.
S. Charleston	P3/L2	0809-1310	1096	T = 4 to 9°C^{f}, RH=49% to 33%^{f}. Wind: W.S.W.^{f}/4 to 8 m/s^{f}.
W. Belle	P3/L5	0729-1241	1084	T = 4 to 9°C^{f}, RH=49% to 33%^{f}. Wind: W.S.W.^{f}/4 to 8 m/s^{f}.
Institute	P3/L8	0728-1210	743	Odor of rotting walnuts, naphthalene or mothballs. T = 4 to 9°C^{f}, RH=49% to 33%^{f}. Wind: W.S.W.^{f}/4 to 8 m/s^{f}.
Nitro	P3/L9	0802-1250	953	Strong odor. T = 4 to 9°C^{f}, RH=49% to 33%^{f}. Wind: W.S.W.^{f}/4 to 8 m/s^{f}.

[a] Sample collected with MAS

[b] Long-term sample collected with duPont personal sampling pump.

[c] Temperature

[d] Pump malfunctioned during sampling period.

[e] Relative humidity.

[f] Data from National Weather Service Forecast Office, Kanawha Airport, Charleston, WV.

[*] General weather conditions for 11/16 through 11/20: Temperatures cool. Skies clear to partly cloudy with very small amount of rain. Winds very brisk with occasional gusts, diminishing to calm on 11/20.

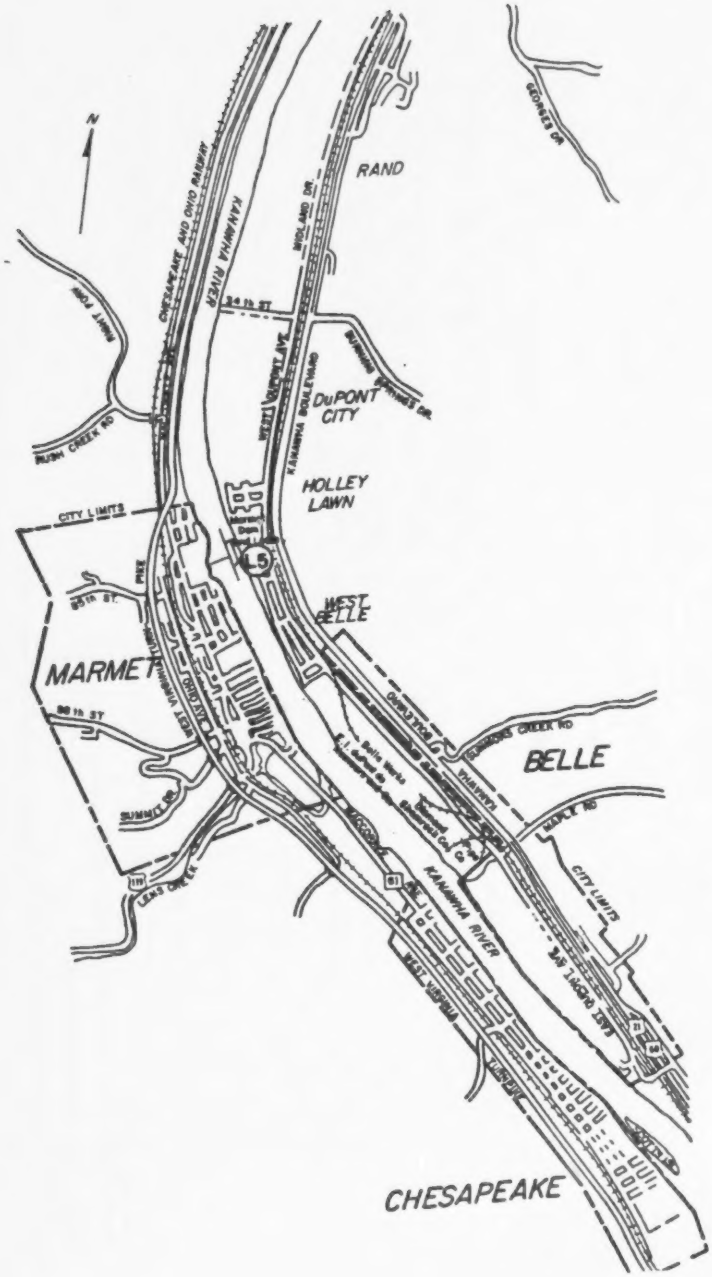

N
RAND
GEORGES DR
CHESAPEAKE AND OHIO RAILWAY
KANAWHA RIVER
MIDLAND DR.
34 th ST
WEST DUPONT AVE.
KANAWHA BOULEVARD
BURNING SPRINGS DR.
DuPONT CITY
RUSH CREEK RD
HOLLEY LAWN
CITY LIMITS
Marmet Dam
L5
PIKE
85th ST.
WEST BELLE
MARMET
WEST VIRGINIA TURNPIKE
90 th ST
BOULEVARD
SLAUGHTERS CREEK RD
BELLE
KANAWHA
E.I. duPont Co Belle Works
SUMMIT RD.
MAPLE RD
Diamond Shamrock Co.
LENS CREEK
119
61
KANAWHA RIVER
CITY LIMITS
EAST DUPONT AVE
WEST VIRGINIA TURNPIKE
21
60
CHESAPEAKE

Figure A9. Map of Belle and Marmet, WV

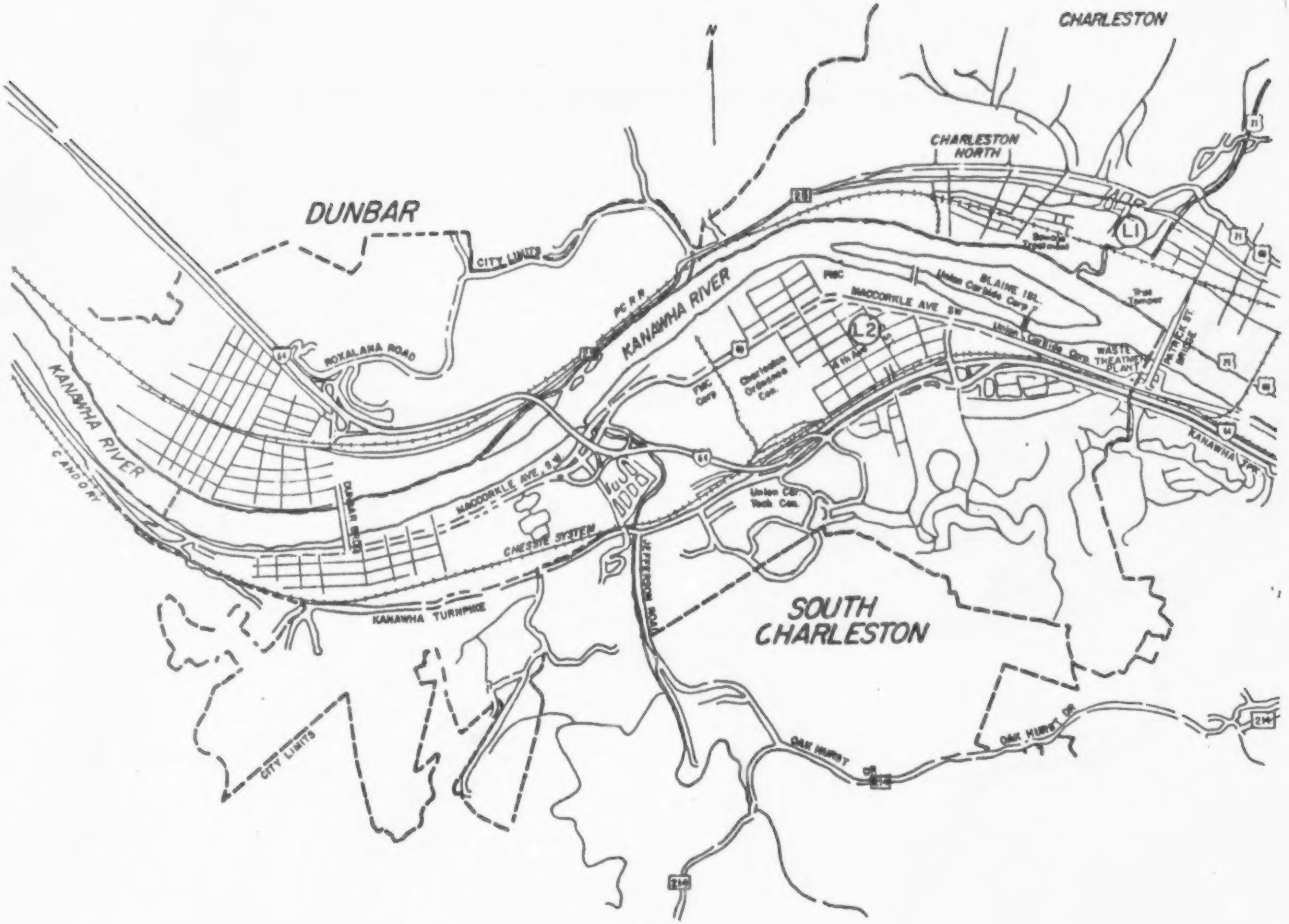

CHARLESTON
N
CHARLESTON NORTH
DUNBAR
CITY LIMITS
L1
L2
BLAINE ISL.
Union Carbide Corp
FMC
MACCORKLE AVE SW
Union Carbide Corp
WASTE TREATMENT PLANT
PATRICK ST. BRIDGE
Charleston Ordnance Cen.
FMC Corp
KANAWHA RIVER
PC R R
ROXALANA ROAD
KANAWHA RIVER
C AND O RY
DUNBAR BRDG
MACCORKLE AVE. S.W.
CHESSIE SYSTEM
KANAWHA TURNPIKE
JEFFERSON ROAD
Union Car. Tech. Cen.
SOUTH CHARLESTON
KANAWHA TPK
OAK HURST DR
OAK HURST DR
CITY LIMITS
21
21
60
60
64
64
214
214

Figure A10. Map of South Charleston and Dunbar, WV

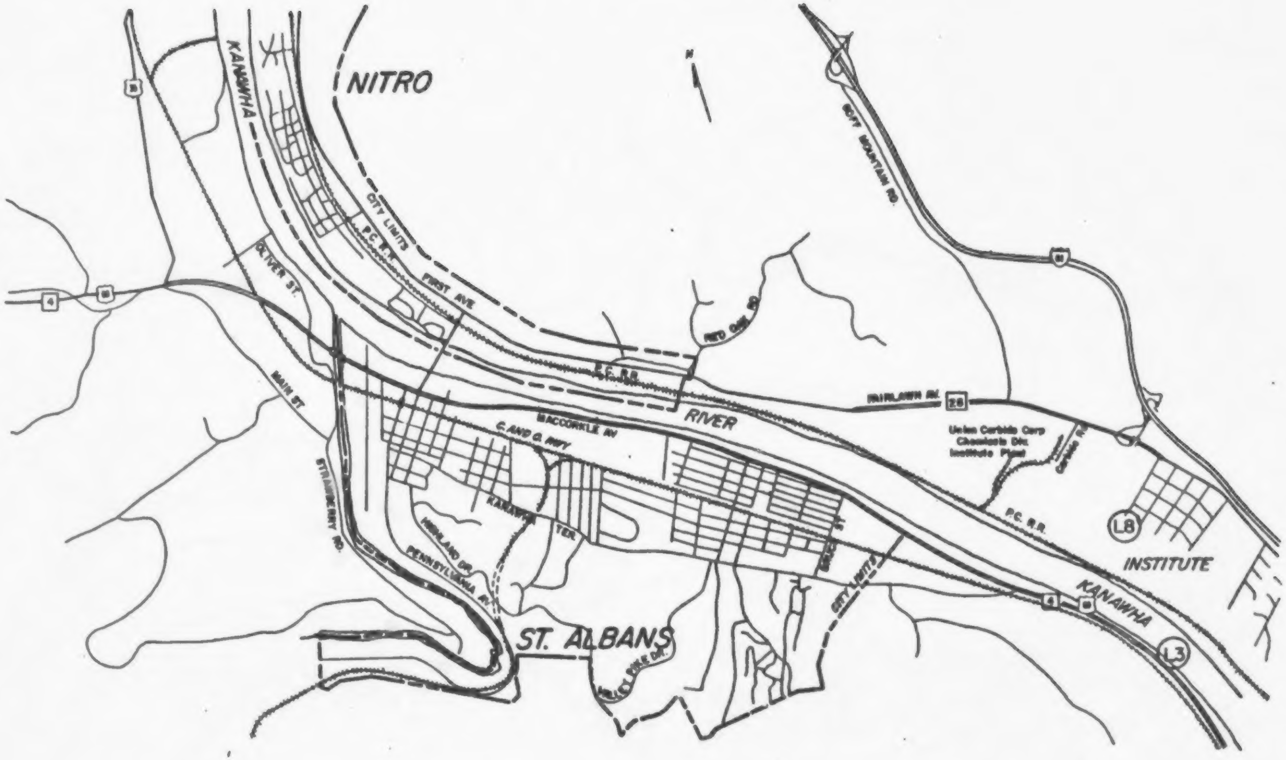

NITRO
KANAWHA
N
CITY LIMITS
P.C. R.R.
FIRST AVE
OLIVER ST.
MAIN ST
4
STRAWBERRY RD.
MACCORKLE AV
C. AND O. RWY
RIVER
KANAWHA TER.
HIGHLAND DR.
PENNSYLVANIA AV
ST. ALBANS
RED OAK RD
GOFF MOUNTAIN RD.
FAIRLAWN AV
25
Union Carbide Corp
Chemicals Div.
Institute Plant
P.C. R.R.
L8
INSTITUTE
CITY LIMITS
4
KANAWHA
L3

Figure A11. Map of Institute, St. Albans and Nitro, WV

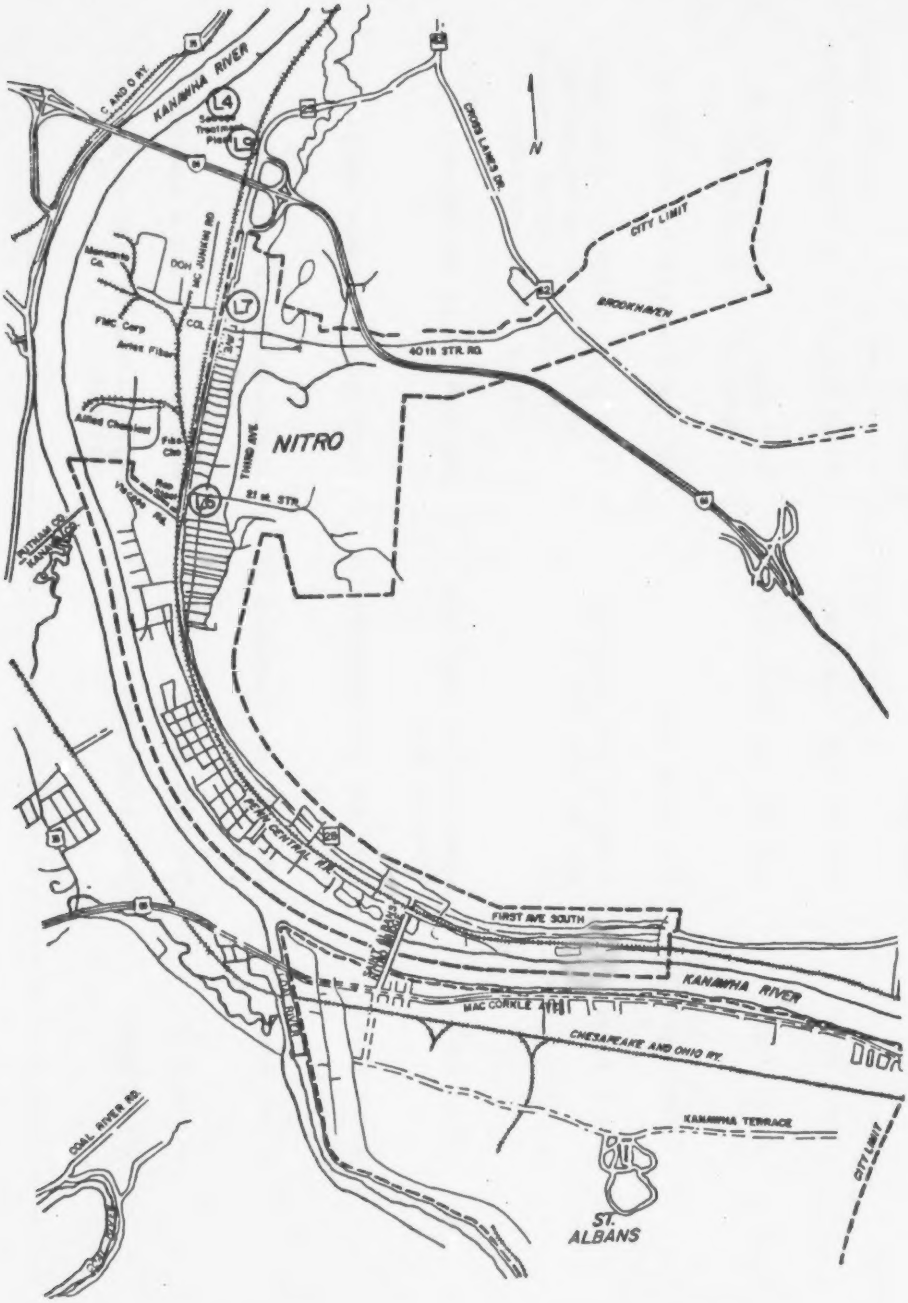

C AND O RY
KANAWHA RIVER
L4
Sewage Treatment Plant
L9
N
CROSS LANES DR.
CITY LIMIT
BROOKHAVEN
Monsanto Co.
DOH
MC JUNKIN RD
L7
FMC Corp
COL
Avtex Fibers
40th STR. RD.
Allied Chemical
Fike Chem
NITRO
THIRD AVE
Rubber Stamp
L6
21 st. STR.
PUTNAM CO.
KANAWHA CO.
PENN CENTRAL RR.
28
FIRST AVE SOUTH
SAINT ALBANS
KANAWHA RIVER
COAL RIVER
MAC CORKLE AVE
CHESAPEAKE AND OHIO RY.
KANAWHA TERRACE
COAL RIVER RD.
ST. ALBANS
CITY LIMIT

Figure A12. Map of Nitro, WV

Table A10. SAMPLING LOCATIONS IN THE SHENANDOAH VALLEY, VA

Location	Site	Address	Remarks
L1	Front Royal	8th St. and Crosby Rd.	Press box at Bing Crosby Stadium.
L2	Front Royal	3rd St. and Villa Ave.	West side of tennis courts at Randolph Macon Academy.
L3	Front Royal	501 Grand Ave.	Back yard of private residence.
L4	Front Royal	Commerce Ave. between 4th St. and 5th St.	Front Royal Volunteer Fire Dept. MAS located on north parking lot. MRI and duPont personal sampler located on roof.
L5	Front Royal	Commerce Ave. and John Marshall Hwy.	Behind Quality Inn Motel.
L6	Front Royal	13th St. and Commonwealth Ave.	South side of tennis courts.
L7	Front Royal	13th St. and Commonwealth Ave.	Commonwealth Ave. playground.
L8	Front Royal	346 10th St.	Back yard of private residence.
L9	Front Royal	1040 Adams Ave.	Garden along S. side of private residence.

Table A11. SAMPLING PROTOCOL FOR SHENANDOAH VALLEY, VA

Site	Period/Location	Sampling Time	Sampling Volume (ℓ)	Remarks[g]
Front Royal	P1/L1	1040-1655	714	At 1040, T[a] = 21°C, RH[b] = 51%. Sky clear. No odor.
Front Royal	P1/L2	1115-1715	336	At 1115, T = 21°C, RH = 40%. Sky clear. No odor.
Front Royal	P1/L3	1140-1728	657	At 1140, T = 22°C, RH = 42%. Sky clear. Noticeable and unpleasant odor. Winds: S.W. at 1140.
Front Royal	P1/L4	1550-1345 (9/29 - 9/30)	22,900,000	T = 6°C to 23°C. Wind: variable/calm to 1.7 m/s
Front Royal	P1/L4	1609-1305 (9/29 - 9/30)	228[d]	T = 6°C to 23°C. Wind: variable/calm to 1.7 c/s no clouds. Some odor.
Front Royal	P2/L3[e]	1735-0715 (9/29 - 9/30)	751[f]	T = 16°C to 19°C. Wind: variable; mostly S.W./calm to 1.4 m/s.
Front Royal	P2/L5[e]	2030-0635 (9/29 - 9/30)	567	T = 11°C to 6°C. Wind: variable/calm to 1.3 m/s. scattered clouds.
Front Royal	P3/L2	0737-1315	457	T = 12°C, RH = 82% at 0734. Sky clear. Heavy emissions and haze over Avtex.
Front Royal	P3/L3	0720-1300	576	T = 27°C, RH = 72% at 1305. Clear to partly cloudy.
Front Royal	P3/L6	0800-1325	325	T = 7°C to 20°C. Wind: variable/0.6 to 1.7 m/s. Faint odor.

[a] Temperature
[b] Relative humidity
[c] Sample collected with MAS
[d] Long-term sample collected with duPont personal sampling pump.
[e] Period 4 was an overnight sampling at two locations to sample potential nighttime emissions and/or settling due to atmospheric inversion.
[f] Pump malfunction during sampling period.

[g] General weather conditions for 9/29 and 9/30: Warm, skies clear to scattered clouds. No precipitation, slight winds.

Table A12. SAMPLING PROTOCOL FOR SHENANDOAH VALLEY, VA

Site	Period/Location	Sampling Time	Sampling Volume (ℓ)	Remarks
Front Royal	P1/L1	1508–2150	397	At 1510, T[a] = 19°C, RH[b] = 95%, overcast, no odor. Wind: N.N.W. to variable/0.8 m/s to calm. T = 19°C[e], RH = 87% to 90%[e].
Front Royal	P1/L2	1455–2115	411	At 1605, T = 20°C, RH = 85%, low ceiling, light drizzle. Slight odor. Wind: N.N.W. to variable/0.8 m/s to calm.
Front Royal	P1/L3	1520–2120	474	At 1600, T = 20°C, RH = 85%, low ceiling. Mild odor. Wind: N.N.W. to variable/0.8 m/s to calm.
Front Royal	P1/L4	1550–0850 (10/27–10/28)	183[c]	At 1550, T = 19°C, RH = 90%, overcast. No odor. Wind: N.N.W. to S.S.W./calm to 1.0 m/s.
Front Royal	P1/L5	1925–2315	457	Wind: variable/calm. T = 19 to 18°C[e], RH = 87% to 90%[e].
Front Royal	P1/L1	2155–0520	383[d]	Wind: variable to S.S.W./calm to 1 m/s. T = 19 to 17°C[e], RH = 87% to 90%[e].
Front Royal	P1/L2	2115–0555	666	Wind: variable to S.S.W./calm to 1 m/s. At 0555, strong odor. T = 19 to 16°C[e], RH = 87% to 90%[e].
Front Royal	P1/L3	2126–0620	705	Wind: variable to S.W.W./calm to 1 m/s. At 0620, no odor noticeable. T = 19 to 16°C[e], RH = 87% to 93%[e].
Front Royal	P1/L5	2330–0645	854	Wind: variable to S.S.W./calm to 1 m/s. Much auto exhaust, diesel fumes. T = 19 to 15°C[e], RH = 87% to 93%[e].

---

[a] Temperature

[b] Relative humidity

[c] Long-term sample collected with duPont personal sampling pump.

[d] Pump malfunctioned during sampling period.

[e] Data from National Weather Service Office, Dulles International Airport, Washington, DC.

*General weather conditions for 10/27 and 10/28: Moderate temperatures with high relative humidities after several days of steady rain. Winds generally calm with skies overcast and low cloud cover.

Table A13. SAMPLING PROTOCOL FOR SHENANDOAH VALLEY, VA

Site	Period/Location	Sampling Time	Sampling Volume (ℓ)	Remarks[*]
Front Royal	P1/L2	1540-2315	814	At 1545, T[a] = 8°C, RH[b] = 59%, wind: N/E~ 2 ms.
Front Royal	P1/L4	1330-0925 (11/14-11/16)	46,300,000[c]	T[a] = 4 to 15°C[e], RH[b] = 37% to 82%[e], winds: E.S.E. to S.S.W.[e]/calm to 7 m/s[e].
Front Royal	P1/L4	1315-0845 (11/14-11/16)	470[d]	At 0845 (11-16), scattered clouds, no odor. Winds: S.S.W. to E.S.E./calm to 7 m/s[e]. T[a]= -4 to 15°C[e], RH[b]= 37% to 82%[e].
Front Royal	P1/L7	1605-2330	1037	At 1600, strong odor apparently from Avtex. At 2330, wind calm, no odor. Winds: S.W.W. to S.S.E./ 2 to 3 m/s[e]. T[a] = 7 to 5°C[e], RH = 37% to 60%[e].
Front Royal	P1/L8	1637-2335	639	At 2335, wind calm, no odor. Winds: S.S.W. to S.S.E./ 2 to 3 m/s[e]. T= 7 to 5°C[e], RH = 37% to 60%[e].
Front Royal	P1/L9	1700-2345	731	At 1700, slight odor. At 2345, no odor. Winds: S.S.W. to S.S.E./ 2 to 3 m/s[e]. T = 7 to 5°C;[e] RH = 37%-60%[d].
Front Royal	P2/L2	1000-1722	535	At 1000, overcast, no odor. T = 6 to 14°C[e], RH = 56% to 42%[e], Winds: S. to S.S.W.[e]/3 to 4 m/s[e].
Front Royal	P2/L7	1047-1705	1125	At 1047, slight odor. At 1705, no odor. T = 6 to 14°C[e] RH = 56% to 42%[e]. Winds: S. to S.S.W.[e]/3 to 4 m/s[e].
Front Royal	P2/L8	1015-1715	478	At 1015, overcast, strong odor. T = 6 to 14°C[e], RH = 56% to 42%[e]. Winds: S. to S.S.W.[e]/3 to 4 m/s[e].
Front Royal	P2/L9	1030-1710	1192	At 1030, odor of cooked apple. At 1710, no odor. T = 6 to 14°C[d], RH = 56% to 42%[e]. Winds: S. to S.S.W.[e]/ 3 to 4 m/s[e].

[a] Temperature.
[b] Relative humidity.
[c] Sample collected with MAS.
[d] Long-term sample collected with duPont personal sampling pump.
[e] Data from National Weather Service Office, Dulles International Airport, Washington, DC.

[*] General weather conditions for 11/14 through 11/16: Cool with clear to partly cloudy skies. Winds calm to brisk with occasional gusts.

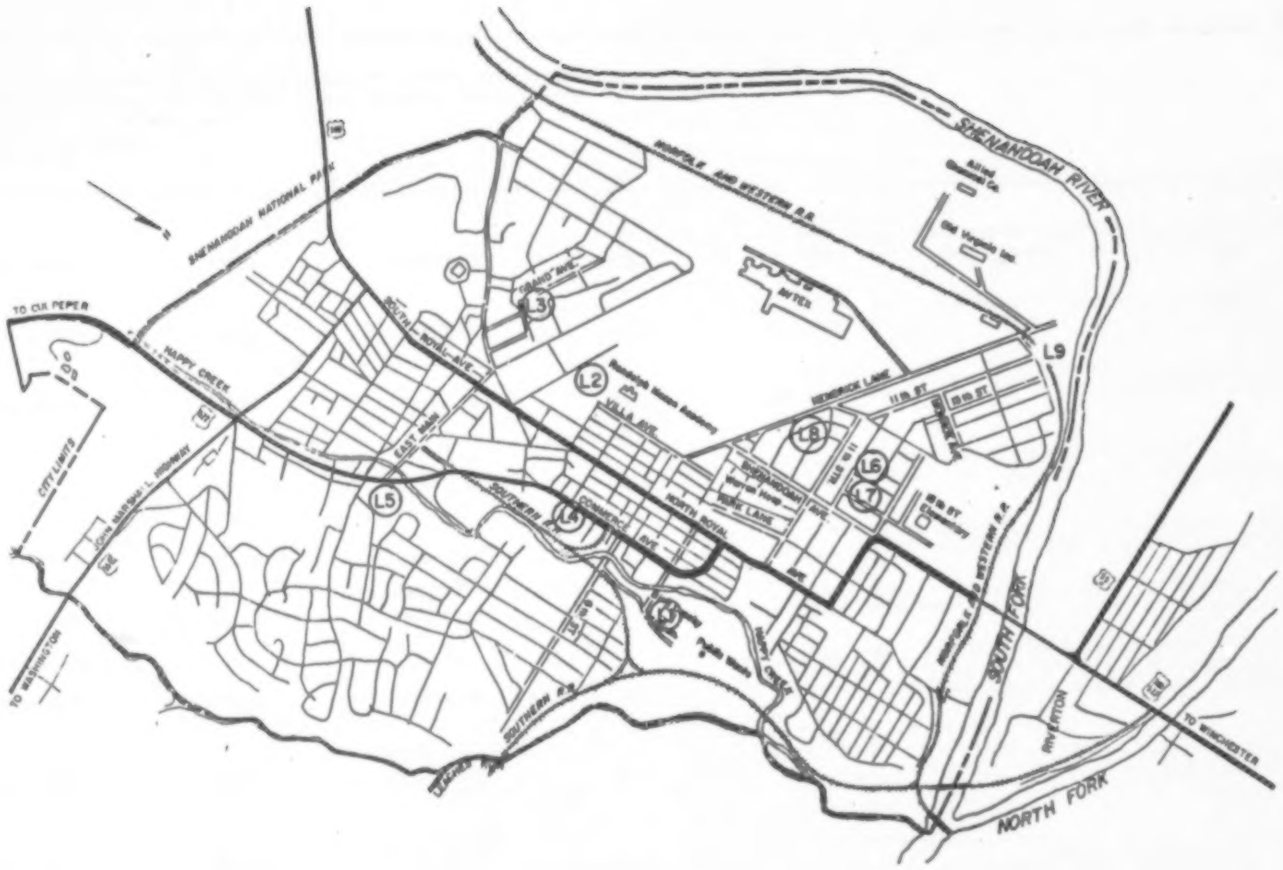

SHENANDOAH RIVER
NORFOLK AND WESTERN R.R.
SHENANDOAH NATIONAL PARK
Allied Chemical Co.
Old Virginia Inc.
AVTEX
TO CULPEPER
HAPPY CREEK
CITY LIMITS
JOHN MARSHALL HIGHWAY
TO WASHINGTON
SOUTH ROYAL AVE
GRAND AVE.
L3
L2
VILLA AVE.
EAST MAIN
L5
SOUTHERN R.R.
L4
COMMERCE AVE
NORTH ROYAL
SHENANDOAH AVE.
PARK LANE
L8
L6
L7
HENDRICK LANE
11th ST
15th ST
L9
SOUTH FORK
NORTH FORK
RIVERTON
TO WINCHESTER
HAPPY CREEK
340
55
522

Figure A13. Map of Shenandoah Valley, VA

Table A14. **AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN SOUTH CHARLESTON, WV**

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)	Ambient Temp. (°C)
3049	SC-1	076/77-078/77	1302-1450 hrs	53.2	18.3 → 21.9 → 21.3
3049	SC-2	078/77-080/77	1508-1639 hrs	44.6	21.3 → 21.6 → 20.5
3049	SC-3	080/77-082/77	1650-1558 hrs	47.2	20.5 → 22.6 → 24.2
3049	SC-4	082/77-084/77	1605-1341 hrs	45.1	23.4 → 23.8 → 21.0
3049	SC-5	084/77-086/77	1349-1010 hrs	42.6	22.3 → 21.1 → 19.8
3049	B[b]	-	-	-	-

[a] Duplicate samples were taken in all cases.

[b] Four blanks were included.

Table A15. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN BIRMINGHAM, AL

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)	Ambient Temp. (°C)
3059	BR-1	4/12-14/77	1616-1630 hrs	118.1	28.9 → 24.3 → 28.5
3059	BR-2	4/14-16/77	1830-1435 hrs	108.2	24.7 → 25.0 → 23.0
3059	BR-3	4/16-18/77	1615-1715 hrs	105.8	23.1 → 20.0 → 20.0
3059	BR-4	4/18-20/77	1830-1400 hrs	107.0	19.2 → 19.8 → 18.2
3059	BR-5	4/20-22/77	1445-1430 hrs	∿ 42.9	20.0 → 20.6 → 20.1
3059	B[b]	-	-	-	-

[a] Duplicate samples were taken in all cases.

[b] Four blanks were included.

Table A16. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN BATON ROUGE, LA

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)	Ambient Temp. (°C)
3069	BA-1	5/12-14/77	1935-1430 hrs	98.7	26.0 → 28.2 → 27.6
3069	BA-2	5/14-16/77	1515-1530 hrs	116.6	29.3 → 28.2 → 24.7
3069	BA-3	5/16-18/77	1535-1400 hrs	115.4	28.5 → 27.6 → 28.4
3069	BA-4	5/18-20/77	1400-0900 hrs	104.5	28.7 → 24.5 → 25.5
3069	B[b]	-	-	-	-

[a] Duplicate samples were taken in all cases.

[b] Four blanks were included.

Table A17. **AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN HOUSTON, TX**

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)	Ambient Temp. (°C)
3079	HO-1	195/77-197/77	1730-930 hrs	113.4	22.4 → 22.3 → 22.4
3079	HO-2	202/77-204/77	1000-900 hrs	113.1	16.9 → 16.5 → 17.5
3079	HO-3	204/77-206/77	1030-0915 hrs	112.2	17.5 → 17.9 → 18.3
3079	HO-4	206/77-208/77	0915-0945 hrs	120.2	18.3 → 19.2 → 28.2
3079	HO-5	208/77-210/77	1000-1015 hrs	115.2[c]	28.3 → 28.1 → 28.6
3079	B^6	-	-	-	-

[a] Duplicate samples were taken in all cases.

[b] Four blanks were included.

[c] Computer down, flow rates were approximated.

Table A17. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN HOUSTON, TX

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)	Ambient Temp. (°C)
3079	HO-1	195/77-197/77	1730-930 hrs	113.4	22.4 → 22.3 → 22.4
3079	HO-2	202/77-204/77	1000-900 hrs	113.1	16.9 → 16.5 → 17.5
3079	HO-3	204/77-206/77	1030-0915 hrs	112.2	17.5 → 17.9 → 18.3
3079	HO-4	206/77-208/77	0915-0945 hrs	120.2	18.3 → 19.2 → 28.2
3079	HO-5	208/77-210/77	1000-1015 hrs	115.2[c]	28.3 → 28.1 → 28.6
3079	B[6]	-	-	-	-

[a] Duplicate samples were taken in all cases.

[b] Four blanks were included.

[c] Computer down, flow rates were approximated.

Table A18. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN UPLAND, CA

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)	Ambient Temp. (°C)
3089	UP-1	225/77-227/77		114	26-27-25
3089	UP-2	227/77-229/77		113	25-28-26
3089	UP-3	229/77-231/77		113	26-29-25
3089	UP-4	231/77-233/77		115	25-27-26
3089	UP-5	233/77-235/77		118	23-28-24
3089	UP-6	235/77-237/77		115	24-29-26
	B	-			

[a] Data to be still provided to RTI by EPA.

Table A19. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN UPLAND, CA

Sampling Site	Code	Date	Period[a]	Volume Sampled	Ambient Temp. (°C)
3089	UP-7	256/77-258/77	1400-0600	96.0	24-27-23
3089	UP-8	258/77-261/77	0600-0030	382.3	24-29-27
3089	UP-9	262/77-264/77	0030-0030	118.1	22-26-25
3089	UP-10	264/77-266/77	0030-0600	108.0	25-28-27
3089	UP-11	266/77-268/77	-[c]	-	
3089	B[b]	-	-	-	

[a] Duplicate samples were taken in all cases.

[b] Four blanks were included.

[c] On-site operator failed to acquire samples.

Table A20. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN MAGNA, UT

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)
3090	SA-1	297/77-299/77	1000-0930	142.5
3090	SA-2	299/77-301/77	1010-1019	144.0
3090	SA-3	301/77-303/77	1045-1045	129.6
3090	SA-4	303/77-305/77	1045-1145	144.2
3090	SA-5	305/77-307/77	1115-1245	130.9
3090	B[b]	-	-	-

[a] Duplicate samples were taken in all cases.

[b] Four blanks were included.

Table A21. AMBIENT AIR SAMPLING PROTOCOL FOR VOLATILE ORGANICS IN THE GRAND CANYON, AR

Sampling Site	Code	Date	Period[a]	Volume Sampled (ℓ)	Ambient Air (°C)
3099	GC-1	332/78-333/78	0930-1030	58	18-20-17
3099	GC-2	333/78-334/78	1030-1015	57	17-21-16
3099	GC-3	334/78-335/78	1015-1015	58	15-19-14
3099	GC-4	335/78-336/78	1015-1640	72	14-16-15
3099	GC-5	336/78-33/78	1645-1613	56	15-18-13
3099	GC-6	337/78-338/78	151-1410	53	13-17-12
3099	GC-7	338/78-339/78	1415-1500	57	12-15-13
3099	B[b]				

[a] Duplicate samples were taken in all periods.

[b] Four blanks were included.

Table A22. AMBIENT AIR SAMPLING PROTOCOL FOR GEISMAR, LA AREA

Sampling Location	Sampling Time (min)	Volume Sampled (ℓ)	Remarks	
Corner of highway 73 and 75 (L12)	1398	140	2/28-3/1/77 28→85% RH	62°F 290→240°/9 kts
Southeast of Plant R (L13)	1400	140	2/28-3/1/77 28→85% RH	62°F 290→240°/9 kts
North of Plant M (L14)-1	260	180	3/1/77 85% RH	63°F 180°/light
Northeast of Plant M and N (L15)	25	142	3/1/77 85% RH	63°F 180°/light
Northwest of Plant M off LA 73 (L14)-2	1205	120	3/1-3/2/77 52% RH	65°F 120°/light
Southwest of Plant M off LA 73 (L16)	135	91	3/2/77 52% RH	65°F 120°/light

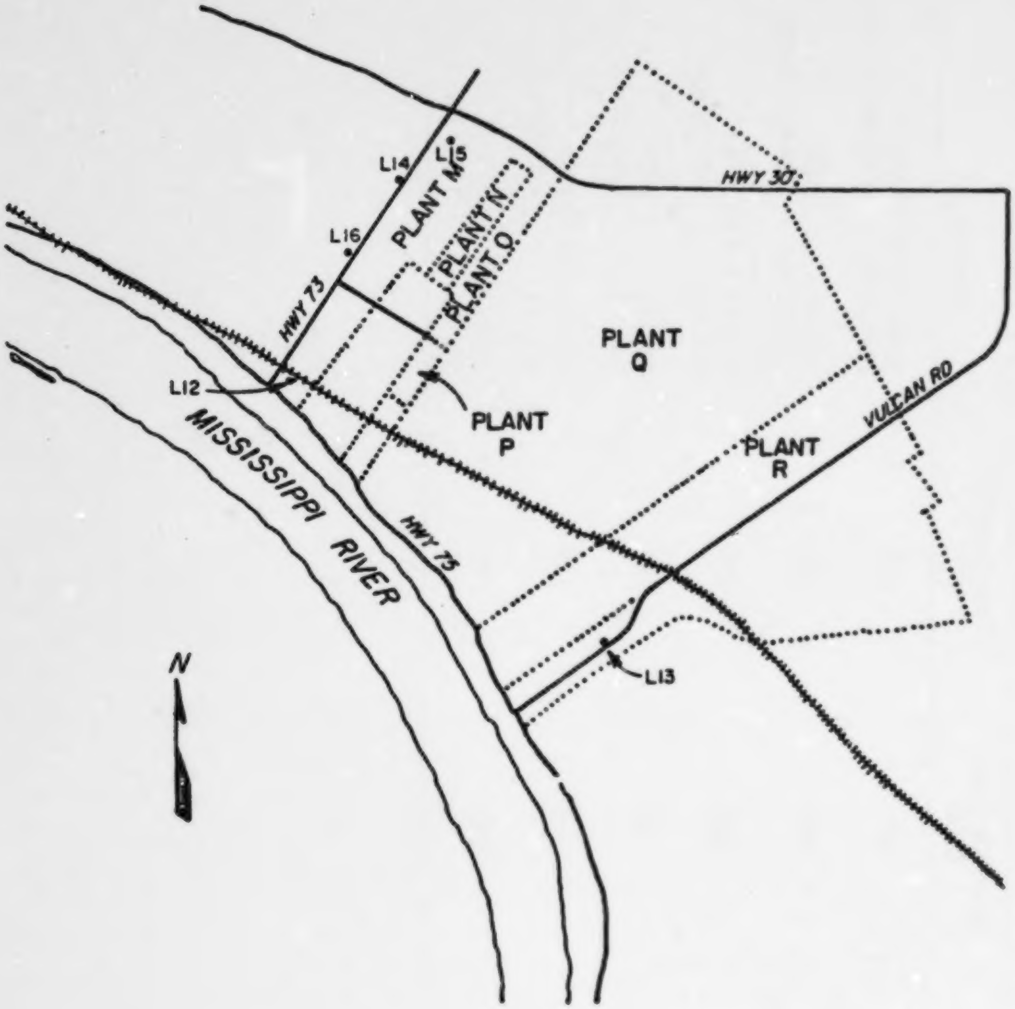

L15
L14
PLANT M
HWY 30
L16
PLANT N
PLANT O
HWY 73
PLANT Q
L12
PLANT P
VULCAN RD
PLANT R
MISSISSIPPI RIVER
HWY 73
N
L13

Figure A14. Sampling site and locations in Geismar, LA area

Table A23. AMBIENT AIR SAMPLING PROTOCOL FOR BATON ROUGE, LA AREA

Sampling Location	Sampling Time (min)	Sampling Volume (ℓ)	Remarks	
Off U.S. 61 North of Plant A (L17)	1400	140	3/3-3/4/77 ~99% RH	1150-1110 120°/light
Off unpaved, unmarked rd. (L18)	1435	143	3/3-3/4/77 ~99% RH	1135-1130 120°/light
Northwest of Plant A on Mr. Ewell's ranch (L19)	235	156	3/3/77 rain	1220-1615 120°/light
Northwest of Plant A on Mr. Ewell's ranch (L20)	260	184	3/4/77 93% RH	1125-1545 90→120°/4 mph
Off unpaved, unmarked rd. (L21)	30	195	3/4/77 93% RH	1207-1237 90°/4 mph
Eastside of LA 61 (L22)	265	146	3/8/77 49% RH	1205-1630 180°/4 mph
Northwest of Plant A on Mr. Ewell's ranch (L20)	195	129	3/8/77 49% RH	1235-1550 180°/4 mph
Off of Turning Basin Rd. (L23)	1190	119	3/8-3/9/77 50% RH	1625-1215 180°/5 mph
Graveyard Area (L24)	1070	107	3/8-3/9/77 50% RH	1640-1030 180°/5 mph

(continued)

Table A23 (cont'd)

Sampling Location	Sampling Time (min)	Sampling Volume (ℓ)	Remarks	
Mengel Rd. (L25)	190	124	3/9/77 54% RH	1330-1640 180°/7 mph
Off LA 61 (L26)	180	121	3/9/77 54% RH	1400-1700 100°/7 mph
Off Mengel Rd. (L27)	1090	109	3/9-3/10/77 54% RH	1650-1100 180°/8-9 mph
Off LA 190 (L28)	1080	108	3/9-3/10/77 54% RH	1715-1115 180°/8-9 mph
Off Mengel Rd. (L25)	190	124	3/9/77 54% RH	1330-1650 100°/7 mph
Off LA 61 (L26)	180	121	3/9/77 54% RH	1400-1700 100°/7 mph
Off Mengel Rd. (L27)	1090	109	3/9-3/10/77 78% RH	1650-1100 180°/8-9 mph
Off LA 61 (L28)	1080	108	3/9-3/10/77 78% RH	1715-1115 180°/8-9 mph
Off Mengel Rd. (L25)	240	162	3/10/77 54% RH	1105-1505 180°/7 mph
Off LA 61 (L26)	250	152	3/10/77 54% RH	1140-1550 180°/7 mph

(continued)

Table A23 (cont'd)

Sampling Location	Sampling Time (min)	Sampling Volume (ℓ)	Remarks	
Choctow Rd. and Pholox St. (L29)	235	173	3/10/77 54% RH	1215-1610 180°/7 mph
LA 1 and LA 190 (L30)	960	96	3/10-3/11/77 75% RH	1700-0900 100°/6 mph

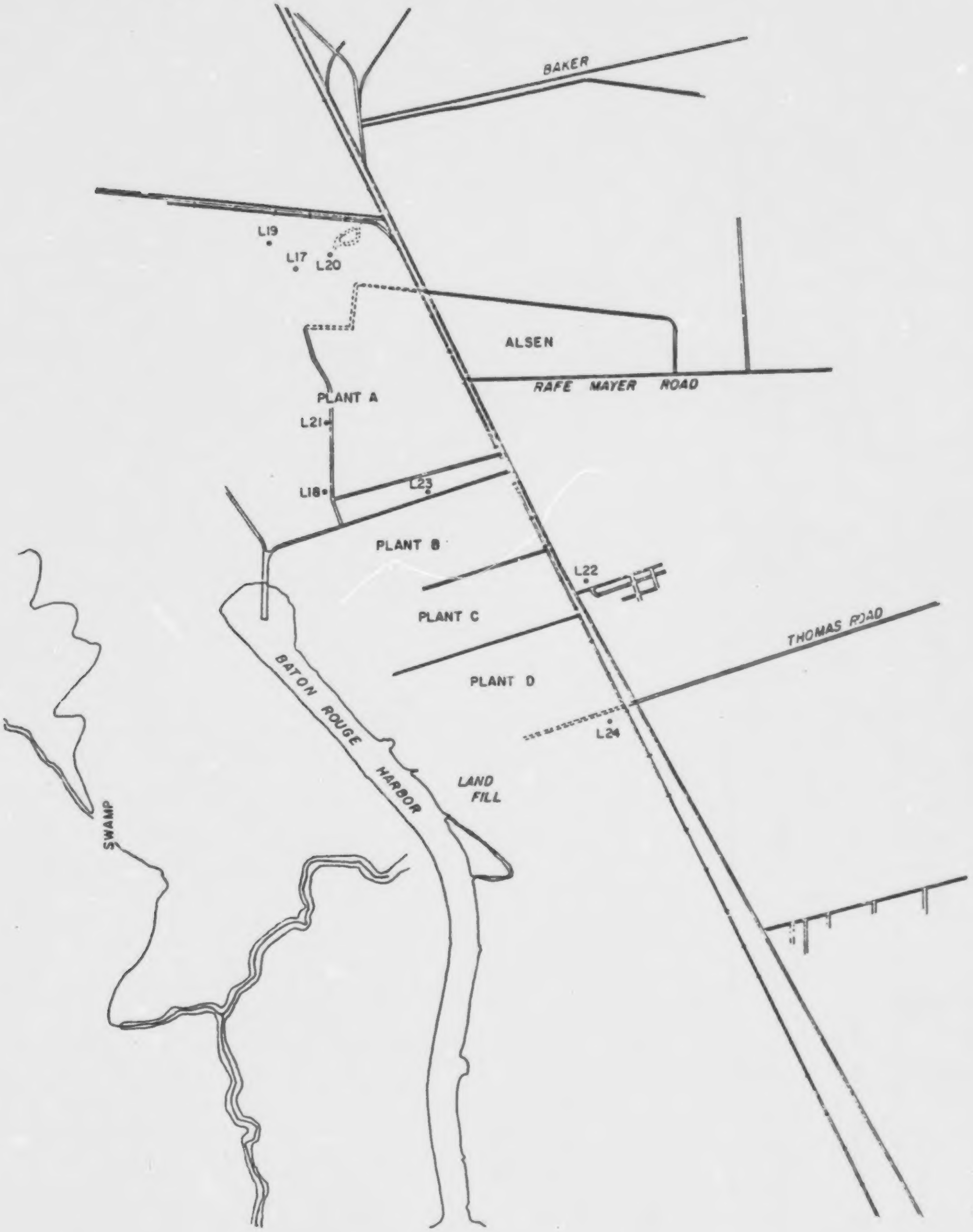

BAKER
L19
L17
L20
ALSEN
RAFE MAYER ROAD
PLANT A
L21
L18
L23
PLANT B
L22
PLANT C
THOMAS ROAD
PLANT D
L24
BATON ROUGE HARBOR
LAND FILL
SWAMP

Figure A15. Sampling site and locations for Baton Rouge, LA Area.

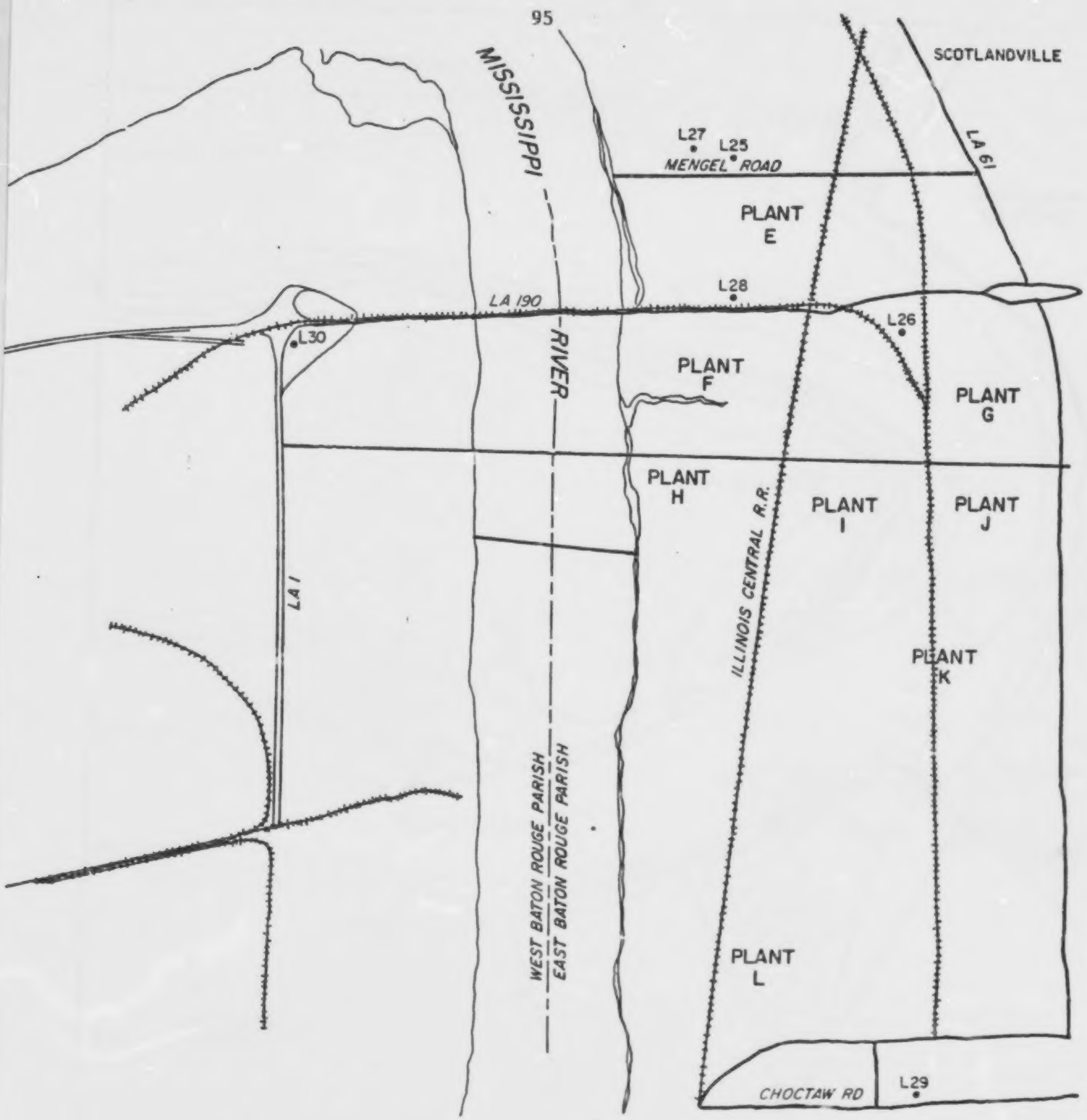
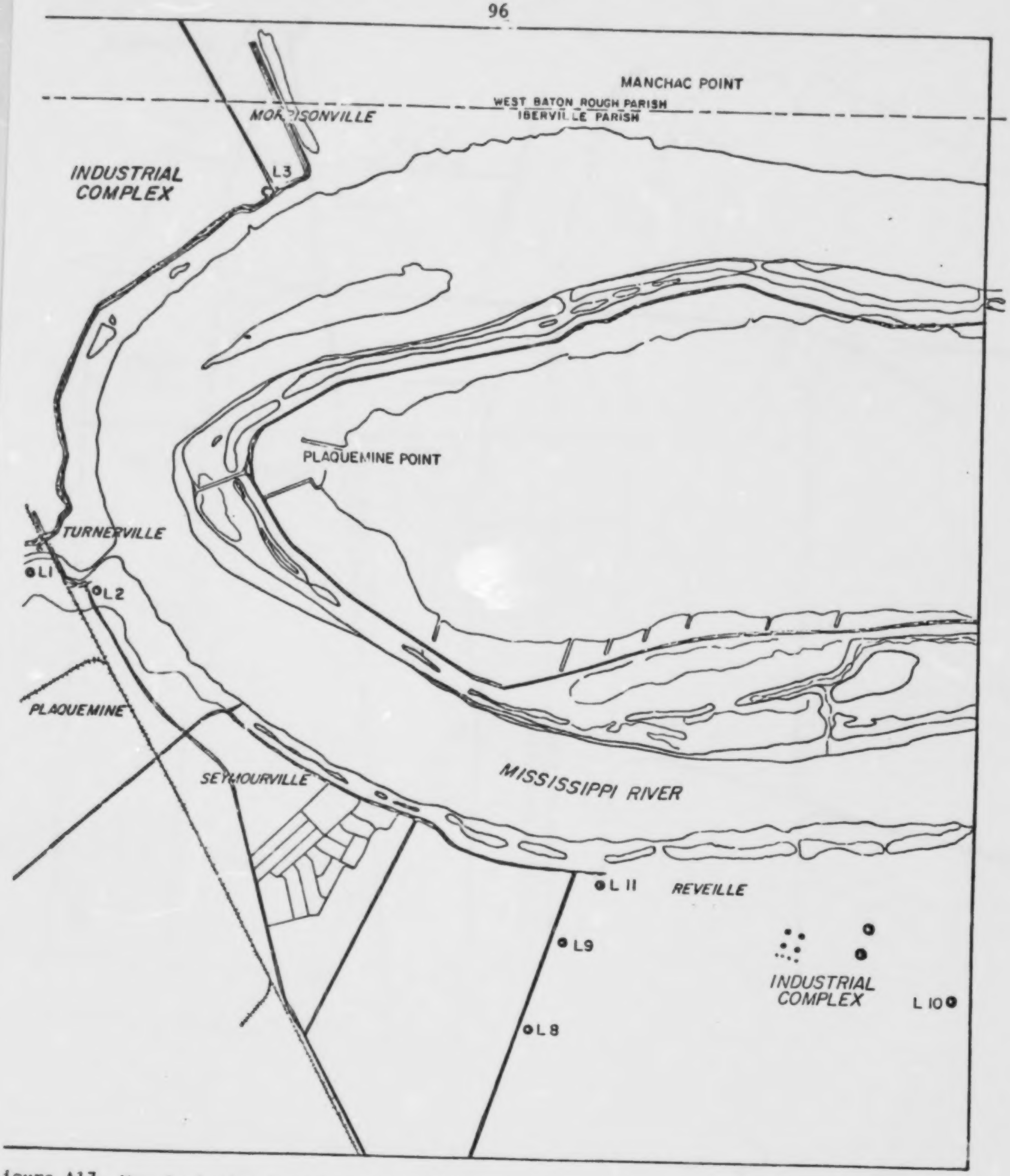

95
MISSISSIPPI
RIVER
SCOTLANDVILLE
L27
L25
MENGEL ROAD
LA 61
PLANT E
L28
LA 190
L26
L30
PLANT F
PLANT G
PLANT H
PLANT I
PLANT J
ILLINOIS CENTRAL R.R.
LA 1
PLANT K
WEST BATON ROUGE PARISH
EAST BATON ROUGE PARISH
PLANT L
CHOCTAW RD
L29

Figure A16. Sampling site and locations in Baton Rouge, LA.


MANCHAC POINT
WEST BATON ROUGH PARISH
IBERVILLE PARISH
MORRISONVILLE
INDUSTRIAL COMPLEX
L3
PLAQUEMINE POINT
TURNERVILLE
L1
L2
PLAQUEMINE
SEYMOURVILLE
MISSISSIPPI RIVER
L 11
REVEILLE
L9
INDUSTRIAL COMPLEX
L 10
L 8

igure A17. Map depicting locations of ambient air sampling network in Iberville Parish, LA.

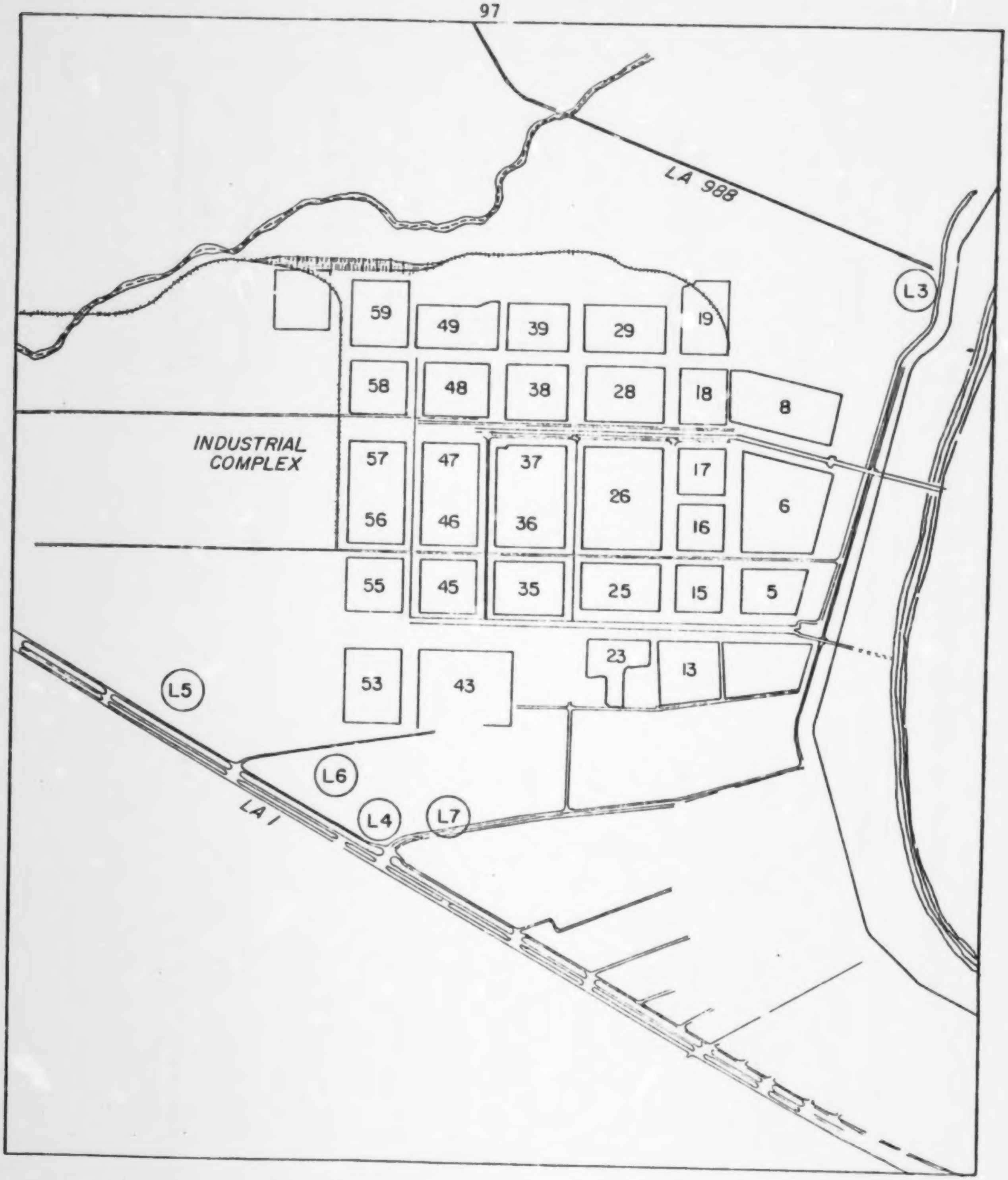

97
LA 988
L3
59
49
39
29
19
58
48
38
28
18
8
INDUSTRIAL COMPLEX
57
47
37
26
17
6
56
46
36
16
55
45
35
25
15
5
23
13
53
43
L5
L6
L4
L7
LA 1

Figure A18. Map depicting sampling locations near industrial complex in Iberville Parish, LA.

Table A24. AMBIENT AIR SAMPLING PROTOCOL FOR PLAQUEMINE, LA AREA

Sampling Locations	Sampling Time (min)	Volume Sampled (ℓ)	Remarks
Plaquemine, LA City Water Tower, Bayou Rd (L1)	1363	136	1/31-2/1/77 1437-1320 44°F-49% RH 0°/1-12 mph
St. John Evangelist Church Tower, Church and Main St. (L2)	1330	133	1/31-2/1/77 1540-1350 44°F-49%RH 0°/1-12 mph
LA 988 & Davis St. (L3)	250	439	2/1/77 1255-1705 44°F-47% RH 70°/1-12 mph
50 yd East off LA 1N (L4)	190	289	2/1/77 1430-1740 44°F-47% RH 70°/1-12 mph
East off LA 1 (L5)	190	129	2/1/77 1445-1755 44°F-36% RH 70°/1-12 mph
Off LA 1 (L6)	1095	109	2/1-2/2/77 1600-1015 44°F-36% RH 90°/1-12 mph
Off LA 1 on Ms. Armalline Caillouet Property (L7)	990	99	2/1-2/2/77 1745-1015 43°F-36% RH 90°/1-12 mph
Plaquemine Evergreen Plantation (L8)	275	191	2/2/77 1250-1725 57°F-55% RH 80°/1-3 mph
Plaquemine Evergreen Plantation (L9)	230	202	2/2/77 1325-1715 57°F-61% RH Variable Winds

Table A24 (cont'd)

Sampling Locations	Sampling Time (min)	Volume Sampled (ℓ)	Remarks	
Plaquemine Evergreen Plantation (L10)	150	100	2/2/77 56°F-55% RH	1400-1630 90°/variable
Plaquemine Evergreen Plantation (L11)	1035	103	2/2-2/3/77 45°F-99% RH	1705-1020 90°/variable

Table A25. AMBIENT AIR SAMPLING PROTOCOL FOR HOUSTON, TX AND VICINITY

Site	Sampling Location	Sampling Time (min)	Volume Sampled (ℓ)	Remarks
Houston, TX	Milby Park (HL1)	1670-1750	188	7/27/76 93°F 60% RH 160°/3 mph
Houston, TX	Off Goodyear Rd., on unpaved St. (HL2)	1510-1515	37	7/27/76 93°F 60% RH 160°/3 mph
Houston, TX	Steelman Ave. & El Buey Way (HL3)	1620-1750	229	7/27/76 93°F 60% RH 160°/3 mph
Pasadena, TX	Between Industrial Site and Ship Channel (HL3)	1430-1600	185	7/28/76 89°F 65% RH 160°/5-10 mph
Pasadena, TX	Tenneco Property (PL2)	1430-1600	237	7/28/76 89°F 65% RH 160°/5-10 mph
Pasadena, TX	Tenneco Property (PL3)	1430-1600	191	7/28/76 89°F 65% RH 160°/5-10 mph
Deer Park, TX	Shell Property (DSL1)	1100-1200	122	7/29/76 87°F 66% RH 180°/4-9 mph
Deer Park, TX	Shell Property (DSL2)	1100-1200	136	7/29/76 87°F 66% RH 180°/4-9 mph
Deer Park, TX	Diamond Shamrock Property (DDL1)	1455-1555	137	7/29/76 94°F 54% RH 130°/4-7 mph
Deer Park, TX	Off Tidal Road (DTL1)	1020-1035	113	7/30/76 90°F 50% RH 210°/6 mph
Deer Park, TX	Off Tidal Road (DTL2)	1115-1215	147	7/30/76 90°F 60% RH 200°/6-8 mph

Table A25 (cont'd)

Site	Sampling Location	Sampling Time (min)	Volume Sampled (ℓ)	Remarks
Deer Park, TX	Off Tidal Road (DTL3)	1455-1555	162	7/29/76 87°F 66% RH 180°/4-9 mph
Deer Park, TX	Off Tidal Road (DTL4)	1115-1215	165	7/30/76 90°F 60% RH 200°/6-8 mph
Freeport, TX	On Dow Chem. Property (FL1)	1342-1543	116	8/9/76 90°F 65% RH 145°/5-10 mph
Freeport, TX	On Dow Chem. Property (FL2)	1348-1555	85	8/9/76 90°F 65% RH 145°/5-10 mph
Freeport, TX	On Dow Chem. Property (FL3)	1425-1508	79	8/9/76 90°F 65% RH 145°/5-10 mph
La Porte, TX	On E. I. DuPont de Nemours & Co. Property (LL1)	1645-1833	110	8/12/76 90°F 62% RH 130-150°/2-6 mph
La Porte, TX	On E. I. DuPont de Nemours & Co. Property (LL2)	1641-1824	82	8/12/76 90°F 62% RH 130-150°/2-6 mph
La Porte, TX	On E. I. DuPont de Nemours & Co. Property (LL3)	1114-1252	87	8/13/76 92°F 53% RH 240°/0-4 mph

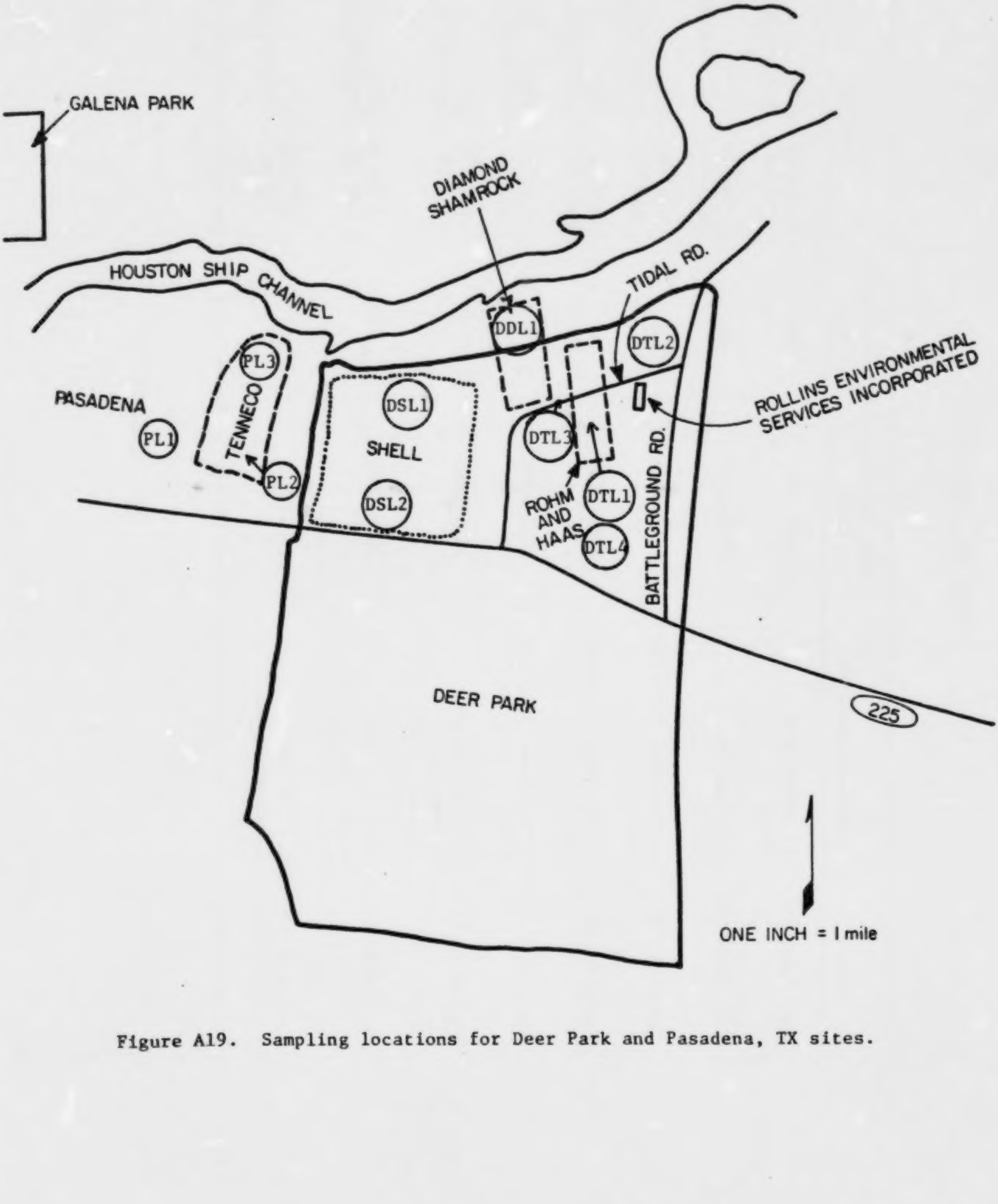

GALENA PARK
DIAMOND SHAMROCK
HOUSTON SHIP CHANNEL
TIDAL RD.
DDL1
DTL2
PL3
ROLLINS ENVIRONMENTAL SERVICES INCORPORATED
PASADENA
DSL1
PL1
TENNECO
SHELL
DTL3
PL2
DSL2
ROHM AND HAAS
DTL1
DTL4
BATTLEGROUND RD.
DEER PARK
225
ONE INCH = 1 mile

Figure A19. Sampling locations for Deer Park and Pasadena, TX sites.

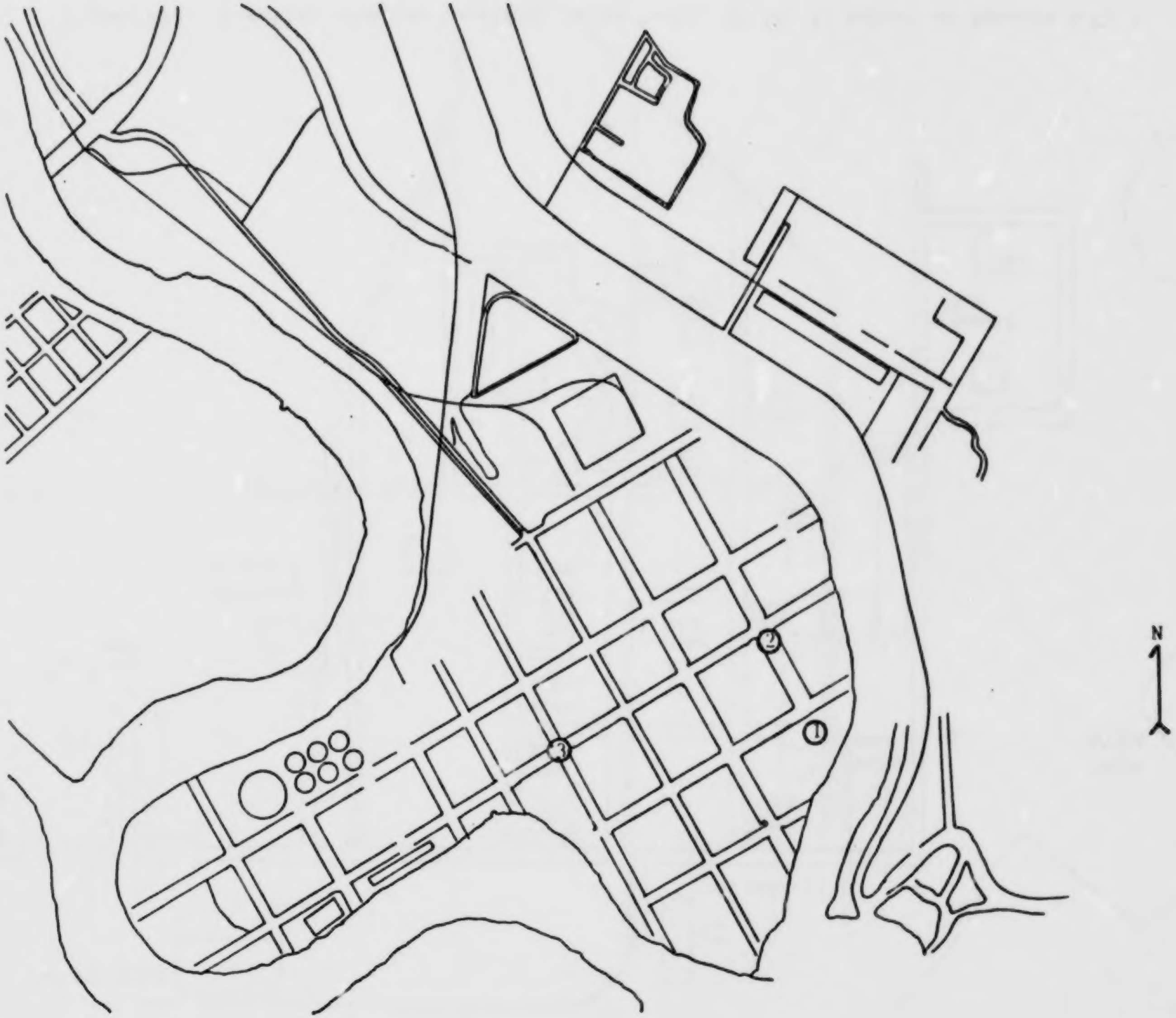


Figure A20. Sampling locations in Freeport, TX (Dow 'A')

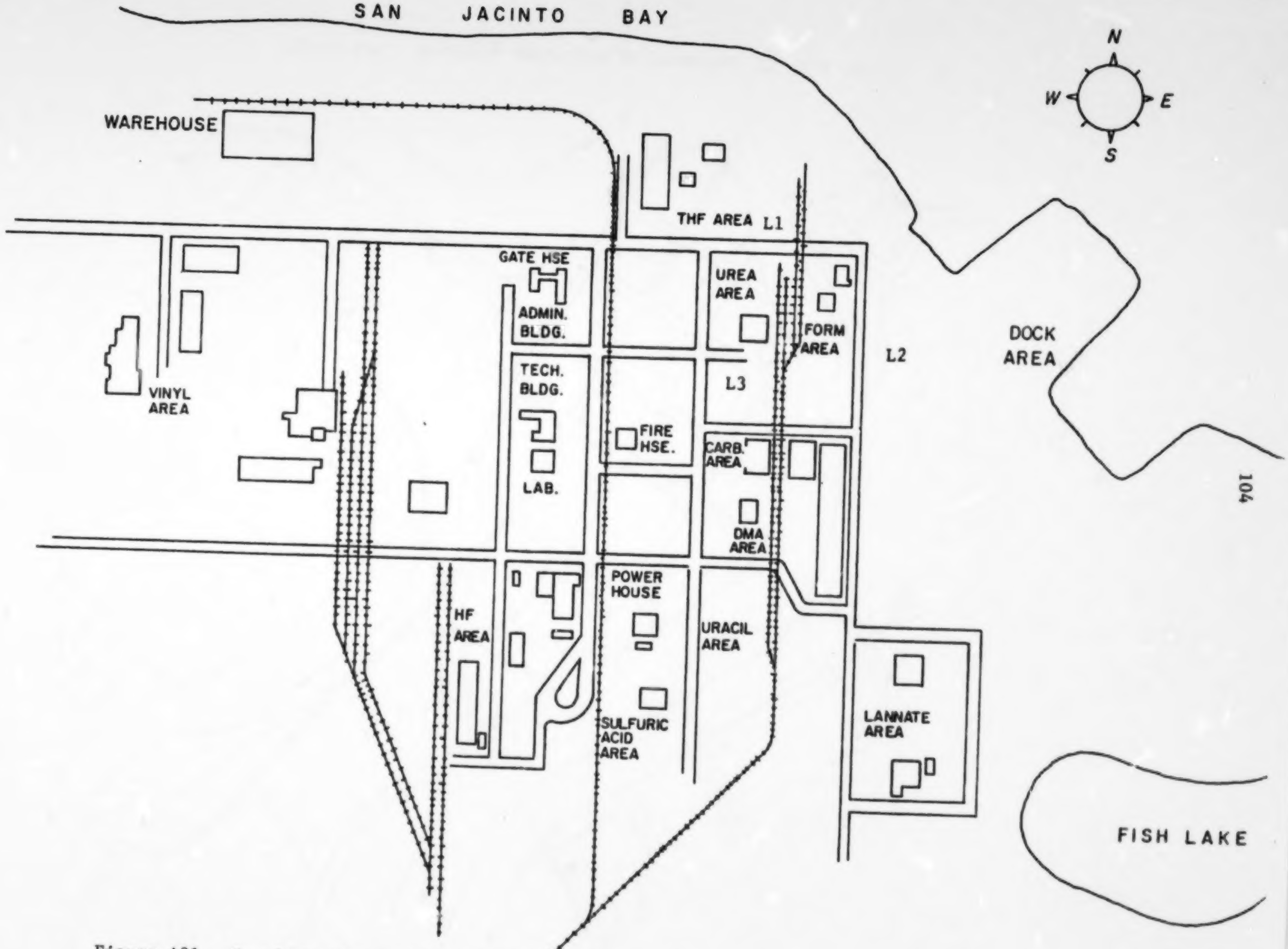

SAN JACINTO BAY
N
W
E
S
WAREHOUSE
THF AREA
L1
GATE HSE
ADMIN. BLDG.
UREA AREA
FORM AREA
L2
DOCK AREA
VINYL AREA
TECH. BLDG.
L3
FIRE HSE.
CARB. AREA
LAB.
DMA AREA
POWER HOUSE
HF AREA
URACIL AREA
SULFURIC ACID AREA
LANNATE AREA
FISH LAKE

Figure A21. Sampling site and locations in La Porte, TX (E. I. DuPont de Nemours & Co.)

Table A26. AMBIENT AIR SAMPLING PROTOCOL FOR LINDEN AND DEEPWATER, NJ

Sampling Site/Period/Location	Sampling Time (min)	Volume Sampled (ℓ)	Remarks
American Cyanamid/P1/L1	140	267	6/21/77 1225-1445 24.4°C 48%RH 0/10 kts
P1/L2	137	194	6/21/77 1228-1445
P1/L3	139	228	6/21/77 1226-1445
P1/L4	138	205	6/21/77 1227-1445
P2/L1	1122	101	6/21-22/77 1603-1045 20°C 40%RG 0/5-7 kts
P2/L2	1150	62	6/21-22/77 1535-1045
P3/L3	1145	103	6/21-22/77 1540-1045
P2/L4	1145	103	6/21-22/77 1530-1045
P3/L1	150	236	6/22/77 1150-1420 27°C 515%RH 0/5-7 kts
P3/L2	150	164	6/22/77 1150-1420
P3/L3	150	222	6/22/77 1150-1420
P3/L4	150	202	6/22/77 1150-1420

Table A26 (cont'd)

Sampling Site/Period/Location	Sampling Time (min)	Volume Sampled (ℓ)	Remarks
E. I. DuPont de Nemours/P4/L5	141	222	6/23/77 1612-1833 24°C 48%RH 220°/∿5 kts
P4/L6	136	147	6/23/77 1602-1818
P4/L7	127	192	6/23/77 1600-1807
P4/L8	120	188	6/23/77 1554-1754
P5/L5	973	88	6/23-24/77 1837-1050 22°C 56%RH 220°/∿3-8 kts
P5/L6	1000	90	6/23-24/77 1823-1103
P5/L7	1018	55	6/23-24/77 1812-1110
P5/L8	1040	92	6/23-24/77 1800-1120
P6/L5			6/24/77 1055-1255 24°C 57%RH 220°/8-10 kts
P6/L6	120	128	6/24/77 1107-1307
P6/L7	120	172	6/24/77 1115-1315
P6/L8	120	183	6/24/77 1125-1325

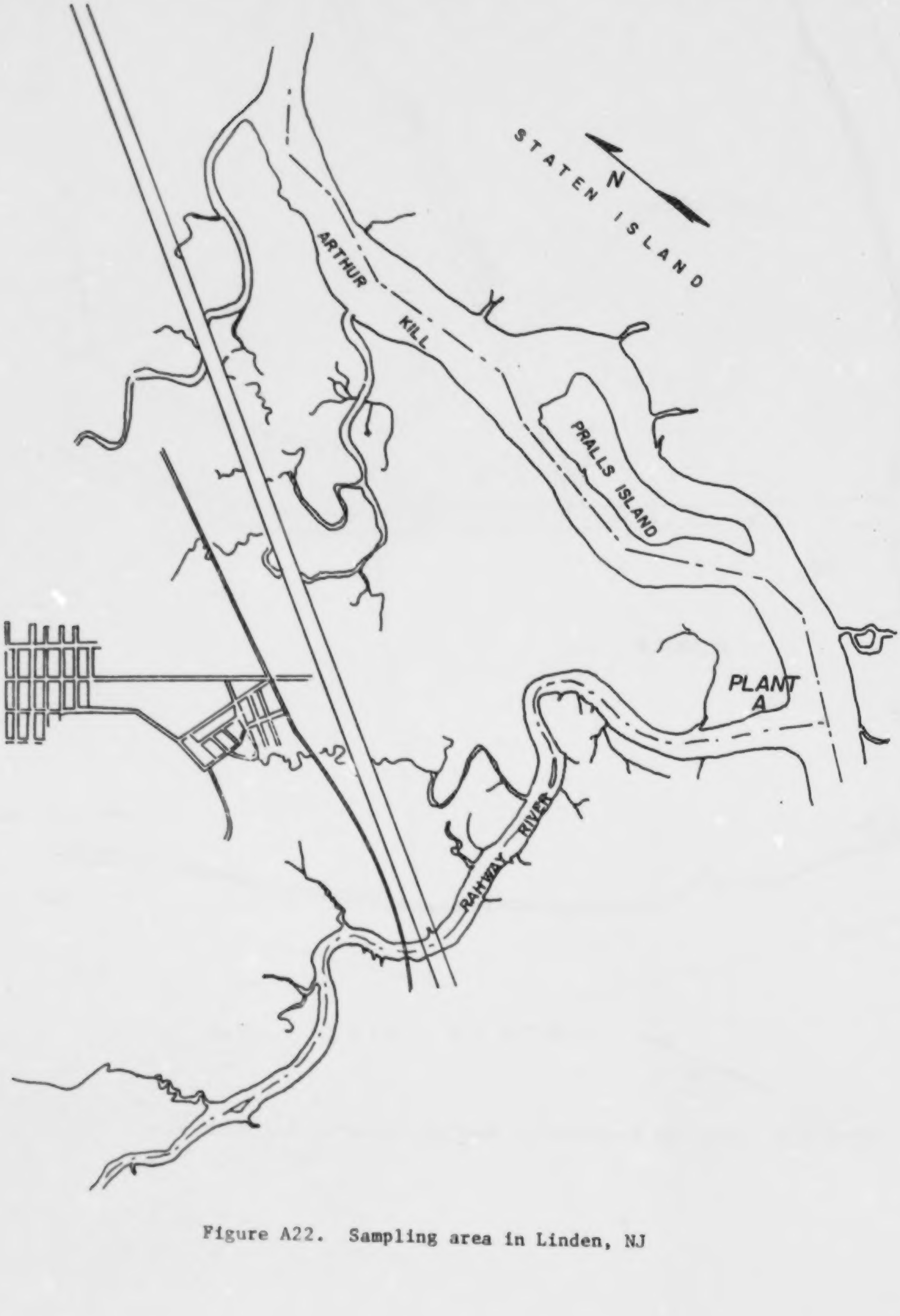

STATEN ISLAND
N
ARTHUR KILL
PRALLS ISLAND
PLANT A
RAHWAY RIVER

Figure A22. Sampling area in Linden, NJ

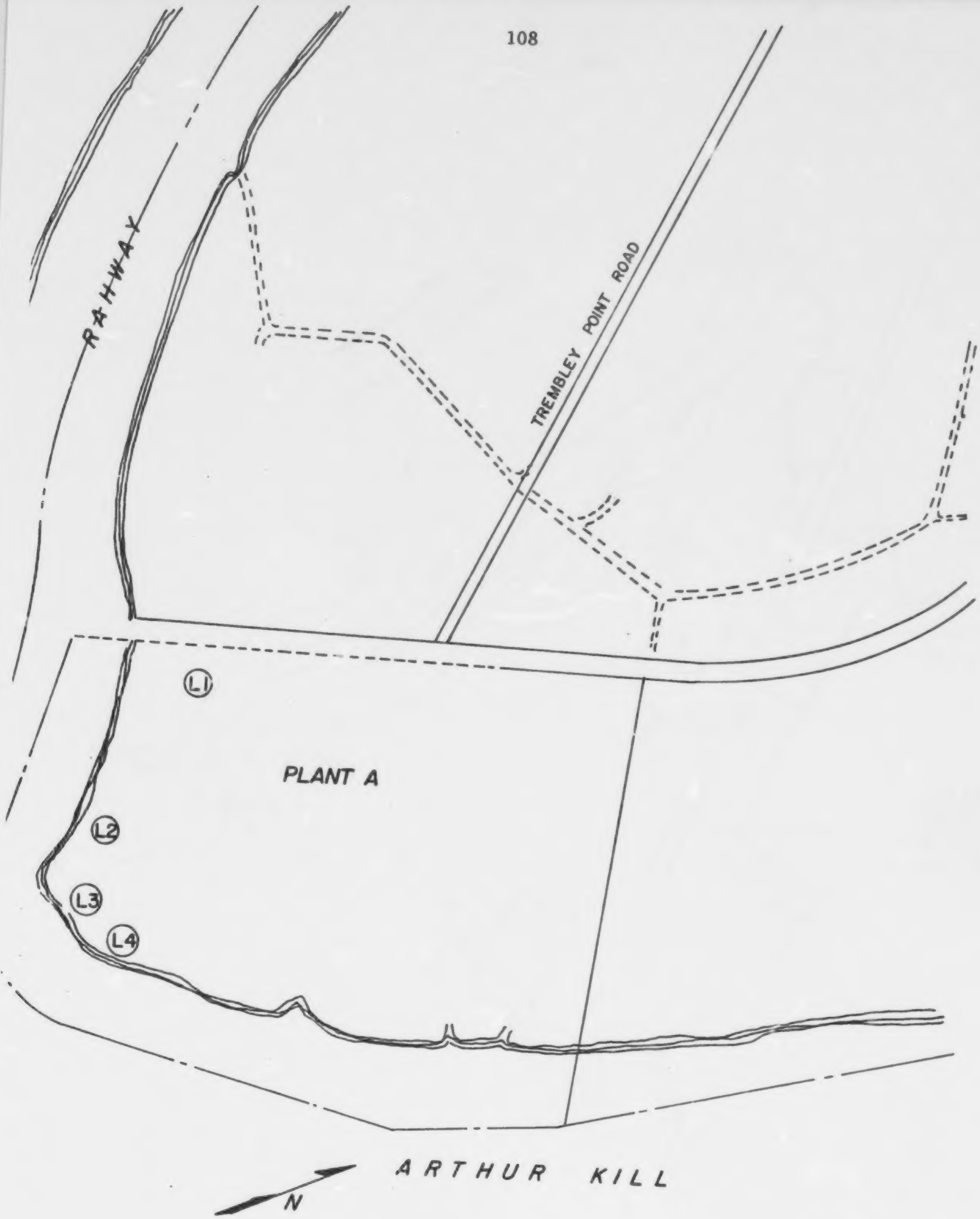

RAHWAY
TREMBLEY POINT ROAD
L1
PLANT A
L2
L3
L4
ARTHUR KILL
N

Figure A23. Sampling locations on American Cyanamid Co. plant site.

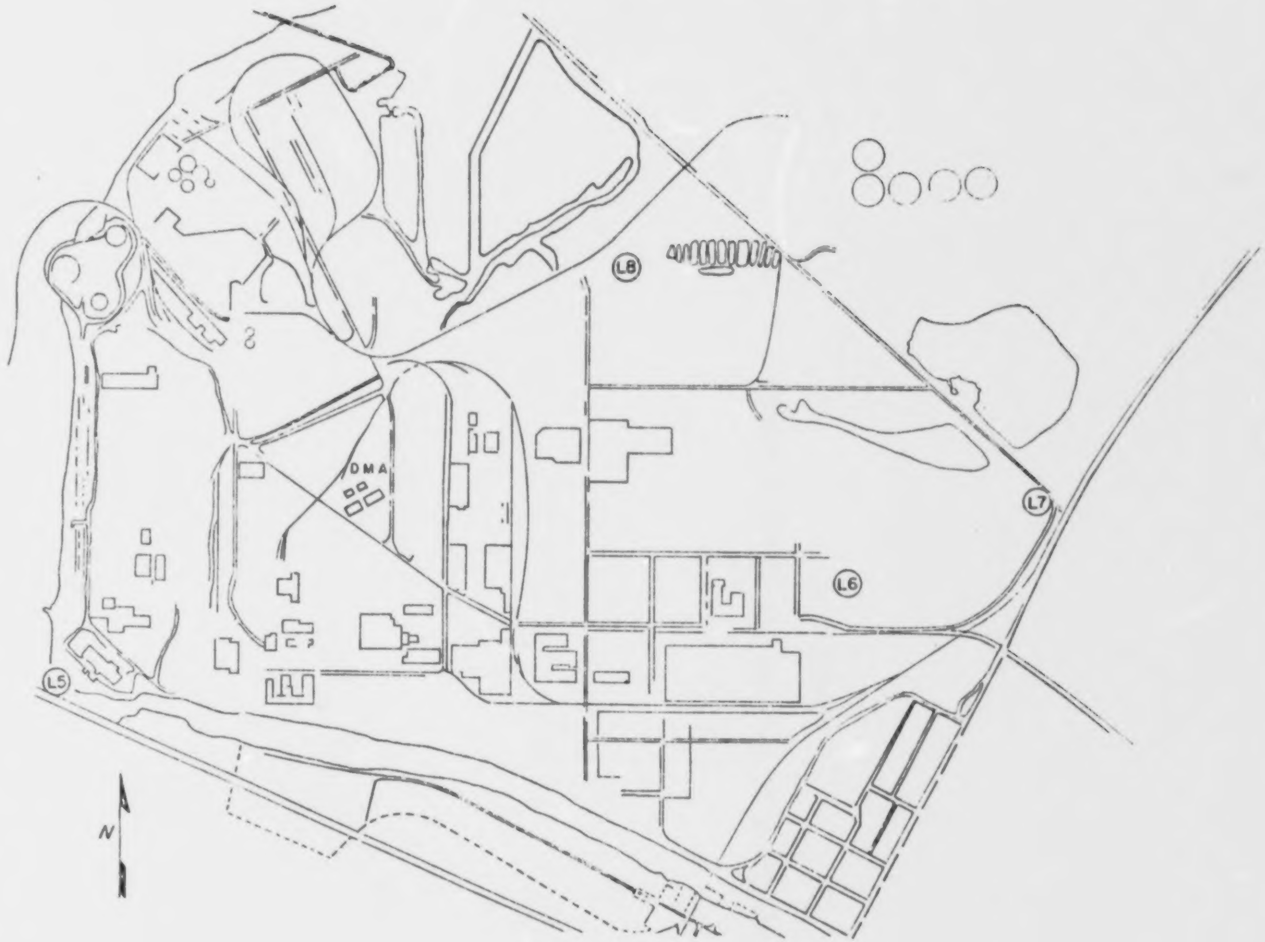

L5
L6
L7
L8
DMA
N

Figure A24. Sampling locations on Chambers Work site of E. I. DuPont de Nemours and Co., Deepwater, NJ.

APPENDIX B

DESCRIPTION OF SAMPLING AND ANALYSIS METHODS

SAMPLING AND ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN AMBIENT AIR

1.0 Principle of Method

Volatile organic compounds are concentrated from ambient air on Tenax GC in a short glass tube (1-3). Recovery of the volatile organics is accomplished by thermal desorption and purging with helium into a liquid nitrogen cooled nickel capillary trap (1,2,4) and then the vapors are introduced into a high resolution glass gas chromatographic column where the constituents are separated from each other (2,5). Characterization and quantification of the constituents in the sample are accomplished by mass spectrometry either by measuring the intensity of the total ion current signal or mass fragmentography (2,6). The collection and analysis systems are shown in Figure B-1.

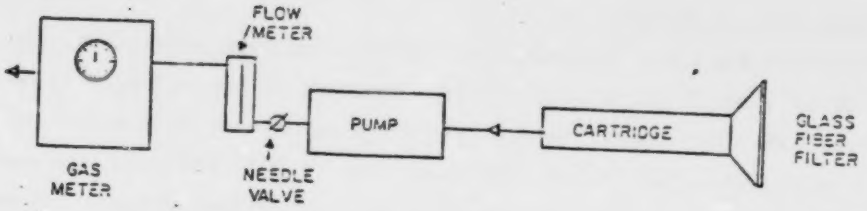
2.0 Range and Sensitivity

The linear range for the analysis of volatile organic compounds depends upon two principal features. The first is a function of the breakthrough volume of each specific compound which is trapped on the Tenax GC sampling cartridge and the second is related to the inherent sensitivity of the mass spectrometer for each organic (2,7). Thus, the range and sensitivity is a direct function of each compound which is present in the original ambient air. The linear range for the quantitation on the gas chromatograph/mass spectrometer/computer (gc/ms/comp) is generally three orders of magnitude. Table B1 lists the overall theoretical sensitivity for some examples of volatile organics which is based on these two principles (7).

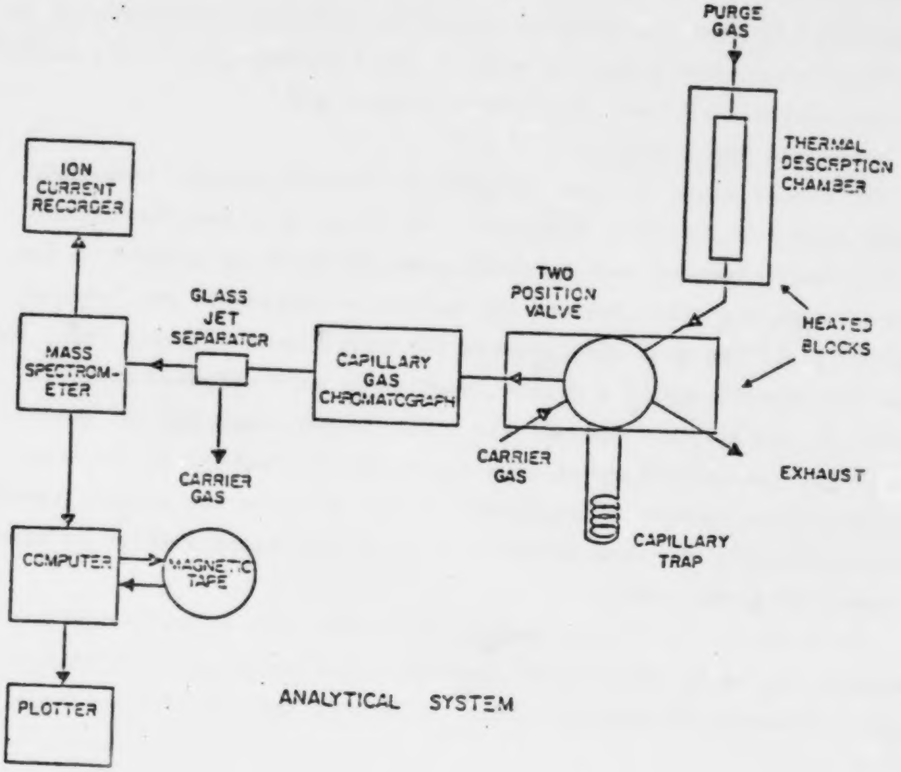
The sensitivity of this technique for the very volatile organic compounds (C_1 to C_5 alkanes) is inadequate for the purpose of this study. Alternate methods for their collection and analysis are suggested (11).

3.0 Interferences

The potential difficulties with this technique are primarily associated with those cases where isomeric forms of a particular substance cannot be resolved by the high resolution chromatographic column and when the mass cracking pattern of each of the isomers are identical. An example of such a problem is seen with the C_5-alkyl aromatics of which


FLOW
/METER
GAS
METER
NEEDLE
VALVE
PUMP
CARTRIDGE
GLASS
FIBER
FILTER

VAPOR COLLECTION SYSTEM


PURGE
GAS
THERMAL
DESORPTION
CHAMBER
ION
CURRENT
RECORDER
TWO
POSITION
VALVE
GLASS
JET
SEPARATOR
HEATED
BLOCKS
MASS
SPECTROM-
ETER
CAPILLARY
GAS
CHROMATOGRAPH
CARRIER
GAS
CARRIER
GAS
EXHAUST
CAPILLARY
TRAP
COMPUTER
MAGNETIC
TAPE
PLOTTER

ANALYTICAL SYSTEM

Figure B1. Vapor collection and analytical systems for analysis of organic vapors in ambient air.

Table B1. OVERALL THEORETICAL SENSITIVITY OF HIGH RESOLUTION GAS CHROMATOGRAPHY/MASS SPECTROMETRY/COMPUTER ANALYSIS FOR ATMOSPHERIC POLLUTANTS

Chemical Class	Compound	Estimated Detection Limit[a]	
		ng/m^3	ppt
Halogenated hydrocarbon	Vinyl bromide	250	57
	Bromoform	0.340	0.03
	Bromodichloromethane	1.300	0.22
	Dibromochloromethane	0.667	0.07
	1-Bromo-2-chloroethane	1.00	0.67
	Allyl bromide	5.00	1.04
	1-Bromopropane	5.200	1.06
	1-Chloro-3-bromopropane	0.150	0.01
	1-Chloro-2,3-dibromopropane	~0.100	<0.01
	1,1-Dibromo-2-chloropropane	~0.100	<0.01
	1,2-Dibromoethane	0.530	0.07
	1,3-Dibromopropane	~0.100	~0.01
	Epichlorohydrin (1-Chloro-2,3-epoxypropane)	9.600	2.50
	Epibromohydrin (1-Bromo-2,3-epoxypropane)	0.300	0.05
	Bromobenzene	0.100	0.02
	Methyl bromide	500	135
	Methyl chloride	2000	1000
	Vinyl chloride	800	333
	Methylene chloride	700	200
	Chloroform	200	420
	Carbon tetrachloride	250	400

(continued)

Table B1 (cont'd)

Chemical Class	Compound	Estimated Detection Limit[a]	
		ng/m^3	ppt
Halogenated hydrocarbon (cont'd)	1,2-Dichloroethane	32	8.15
	1,1,1-Trichloroethane	66	12.45
	Tetrachloroethylene	2.5	0.38
	Trichloroethylene	10	1.92
	1-Chloro-2-methylpropene	62	21.5
	3-Chloro-2-methylpropene	62	21.5
	3-Chloro-1-butene	83	28.8
	Allyl chloride	83	28.8
	4-Chloro-1-butene	38	13.2
	1-Chloro-2-butene	13	4.5
	Chlorobenzene	2.10	0.47
	o-Dichlorobenzene	1.00	0.06
	m-Dichlorobenzene	0.75	0.01
	Benzylchloride	0.65	0.01
Halogenated ethers	2-Chloroethyl ethyl ether	4.15	0.97
	Bis-(chloromethyl)ether	1.0	1.10
Nitrosamines	N-Nitrosodimethylamine	5.0	1.67
	N-Nitrosodiethylamine	3.0	0.74
Oxygenated hydrocarbons	Acrolein	~100	56.5
	Glycidaldehyde	~59	9.5
	Propylene oxide	~60	25.5

(continued)

Table B1 (cont'd)

Chemical Class	Compound	Estimated Detection Limit[a]	
		ng/m^3	ppt
Oxygenated hydrocarbons (cont'd)	Butadiene diepoxide	~20	6.7
	Cyclohexene oxide	~10	2.5
	Styrene oxide	2	0.415
	Acetophenone	~2	~0.415
	β-Propiolactone	~3	~1.2
Nitrogenous Compounds	Nitromethane	8	~2.4
	Aniline	3.0	0.78
Sulfur Compounds	Diethyl sulfate	~50	-
	Ethyl methane sulfate	~5.0	-

---

[a] Limits are calculated on the basis of the breakthrough volume for 2.2 g of Tenax GC, (at 70°F), capillary column performance and sensitivity of the mass spectrometer to that compound in the mass fragmentography mode of most intense ion.

there are 53 isomers. As the number of carbon atoms increases in the hydrocarbons and aromatics, the number of potential isomers becomes increasingly large and difficult to completely resolve by gas chromatography and/or by their corresponding mass cracking patterns. However, differentiation between the hydrocarbons, that is alkanes, alkenes, aromatics, oxygenated, etc. can be accomplished.

4.0 Reproducibility

The reproducibility of this method has been determined to range from ±10 to ±30% of the relative standard deviation for different substances when replicate sampling cartridges are examined (5). The inherent analytical errors are a function of several factors: [1] the ability to accurately determine the breakthrough volume for each of the identified organic compounds, [2] the accurate measurement of the ambient air volume sampled, [3] the percent recovery of the organic from the sampling cartridge after a period of storage, [4] the reproducibility of thermal desorption for a compound from the cartridge and its introduction into the analytical system, [5] the accuracy of determining the relative molar response ratios between the identified substance and the external standard used for calibrating the analytical system, [6] the reproducibility of transmitting the sample through the high resolution gas chromatographic column and, [7] the day-to-day reliability of the ms/comp system (1-8).

The accuracy of analysis is generally ±30% but depends on the chemical and physical nature of the compound (2,8).

5.0 Advantages and Disadvantages of the Method

The gas chromatograph/mass spectrometer interfaced with a glass jet separator, is extremely sensitive and specific for the analysis of many volatile organic compounds in ambient air. High resolution gas chromatographic separation provides adequate resolution of the substances found in ambient air for their subsequent quantification. The combination of the high resolution gas chromatographic column and the selection of specific or unique ions representing the various compounds of interest identified in the air samples yields a relatively specific assay method for these compounds (1-8).

Collected samples can be stored up to one month with less than 10% losses for most of the chemical classes (2,8). Because some of the compounds of interest may be hazardous to man, it is extremely important to exercise safety precautions in the preparation and disposal of liquid and gas standards, cleaning of used glassware, etc. in the analysis of air samples.

Since the mass spectrometer cannot be conveniently mobilized, sampling must be carried out away from the instrument.

The efficiency of air sampling increases as the ambient air decreases (i.e., sensitivity increases) (8).

The retention of water by Tenax is low; its thermal stability is high; and its background is negligible allowing sensitivity analysis (1,2,5,8).

6.0 Apparatus

6.1 Sampling Cartridges

The sampling tubes are prepared by packing a ten centimeter long by 1.5 cm i.d. glass tube containing 6 cm of 35/60 mesh Tenax GC with glass wool in the ends to provide support (2,5). Virgin Tenax (or material to be recycled) is extracted in a Soxhlet apparatus for a minimum of 18 hours each time with acetone and hexane prior to preparation of cartridge samplers (2,5). After purification of the Tenax GC sorbent and drying in a vacuum oven at 100°C for 3 to 5 hours at 28 inches of water, all the sorbent material is meshed to provide a 35/60 particle size range. Cartridge samplers are then prepared and conditioned at 270°C with helium flow at 30 ml/min for 30 min. The conditioned cartridges are transferred to Kimax® (2.5 cm x 150 cm) culture tubes immediately sealed using Teflon-lined caps and cooled. This procedure is performed in order to avoid recontamination of the sorbent bed (2,5).

Cartridge samplers with longer beds of sorbent may be prepared using a proportionally increased amount of Tenax in order to achieve a larger breakthrough volume for compounds of interest, and thus increasing the overall sensitivity of the technique (8).

6.2 Gas Chromatographic Column

A 0.35 mm i.d. x 100 m glass SCOT capillary column coated with SE-30 stationary phase and 0.1% benzyltriphenylphosphonium chloride is used for effecting the resolution of the volatile organic compounds (5). The capillary volume is conditioned for 48 hrs. at 245° at 2.25 ml/min of helium flow.

A glass jet separator on a Varian MAT CH-7 gc/ms/comp system is employed to interface the glass capillary column to the mass spectrometer. The glass jet separator is maintained at 240°C (2,5).

6.3 Inlet Manifold

An inlet manifold for thermally recovering vapors trapped on Tenax sampling cartridges is used and is shown in Figure B1 (1,2,4,5).

6.4 Gas Chromatograph

A Varian 1700 gas chromatograph is used to house the glass capillary column and is interfaced to the inlet manifold (Figure B1).

6.5 Mass Spectrometry/Computer

A Varian MAT CH-7 mass spectrometer with a resolution of 2,000 equipped with a single ion monitoring capability is used in tandem with a gas chromatograph (Figure B1). The mass spectrometer is interfaced to a Varian 620/L computer (Figure B1).

7.0 Reagents and Materials

All reagents used are analytical reagent grade.

8.0 Procedure

8.1 Cleaning of Glassware

All glassware, sampling tubes, cartridge holders, etc. are washed in Isoclean/water, rinsed with deionized distilled water, acetone and air dried. Glassware is heated to 450-500°C for 2 hours to insure that all organic material has been removed prior to its use.

8.2 Preparation of Tenax GC

Virgin Tenax GC is extracted in a Soxhlet apparatus for a minimum of 18 hours with acetone or methanol prior to its use. The Tenax GC sorbent is dried in a vacuum oven at 100°C for 3-5 hours and then sieved to provide a fraction corresponding to 35/60 mesh. This fraction is used for preparing sampling cartridges. In those cases where sampling cartridges of Tenax GC are recycled, the sorbent is extracted in a Soxhlet apparatus with acetone or methanol as described for the virgin material, but the sorbent is further extracted with a non-polar solvent, hexane, in order to remove the relatively non-polar and non-volatile materials which might have accumulated on the sorbent bed during previous sampling periods.

8.3 Collection of Volatile Organics in Ambient Air

Continuous sampling of ambient air is accomplished using a Nutech Model 221-A portable sampler (Nutech Corp., Durham, NC, see Figure B1, Reference 2). Flow rates between 1-10 ℓ/min are available with this sampling system. Flow rates are generally maintained at 1 ℓ using critical orifices and the total flow is monitored through a calibrated flow meter. The total flow is also registered by a dry gas meter. Con-concomitant with these parameters the temperature is continuously recorded with a Meterological Research, Inc. Weather Station since the breakthrough volume is important in order to obtain quantitative data on the volatile organics. This portable sampling unit operates on a 12 volt storage battery and is capable of continuous operation up to a period of 24 hours. However, in most cases at the rates which are employed in the field, the sampling period is generally 1-3 hours. This portable sampling unit is generally utilized for obtaining "high volume" samples. Duplicate cartridges are deployed on each sampling unit utilizing a sampling head as shown in Figure B2.

In addition to the Nutech samplers, DuPont personnel samplers are also used to acquire "low volumes" of ambient air as well as long-term integrated samples (12-36 hrs). Identical Tenax GC sampling cartridges are employed in this case, and the sampling is conducted in duplicate. The flow rate is balanced between duplicate cartridges using critical orifices to maintain a rate of 25-100 ml/min per cartridge.

For large sample volumes, it is important to realize that a total volume of air may cause the elution of compounds through the sampling tube if their breakthrough volume is exceeded. The breakthrough volumes of some of the volatile organics are shown in Table B2 (2,4,7,8). These breakthrough volumes have been determined by a previously described technique (2). The breakthrough volume is defined as that point at which 50% of a discrete sample introduced into the cartridge is lost. Although the identity of a compound during ambient air sampling is not known (therefore, also its breakthrough volume), the compound can still be quantified after identification by gc/ms/comp once the breakthrough

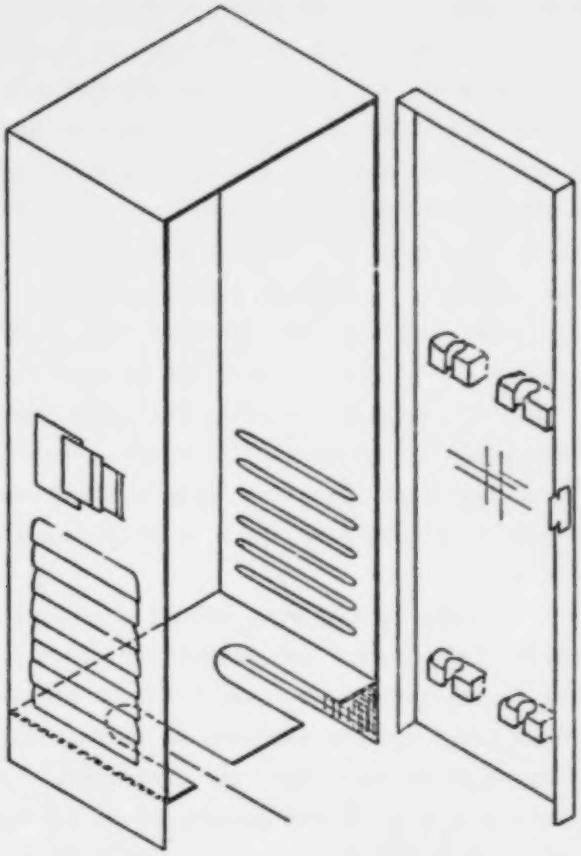


Figure B2. Sampling head for housing cartridge sampling train.

Table B2. **TENAX GC BREAKTHROUGH VOLUMES FOR SEVERAL ATMOSPHERIC POLLUTANTS**[1]

Chemical Class	Compound	b.p. (°C)	Temperature (°F) 50	60	70	80	90	100
Halogenated hydrocarbon	methyl chloride	-24	8	6	5	4	3	2.5
	methyl bromide	3.5	3	2	2	1	1	0.9
	vinyl chloride	13	2	1.5	1.25	1.0	0.8	0.6
	methylene chloride	41	11	9	7	5	4	3
	chloroform	61	42	31	24	18	13	10
	carbon tetrachloride	77	34	27	21	16	13	10
	1,2-dichloroethane	83	53	41	31	23	18	14
	1,1,1-trichloroethane	75	23	18	15	12	9	7
	tetrachloroethylene	121	361	267	196	144	106	78
	trichloroethylene	87	90	67	50	38	28	21
	1-chloro-2-methylpropene	68	26	20	16	12	9	7
	3-chloro-2-methylpropene	72	29	22	17	13	10	8
	1,2-dichloropropane	95	229	162	115	81	58	41
	1,3-dichloropropane	121	348	253	184	134	97	70
	epichlorohydrin (1-chloro-2,3-epoxypropane)	116	200	144	104	74	54	39
	3-chloro-1-butene	64	19	15	12	9	7	6
	allyl chloride	45	21	16	12	9	6	5
	4-chloro-1-butene	75	47	36	27	20	15	12
	1-chloro-2-butene	84	146	106	77	56	40	29
	chlorobenzene	132	899	653	473	344	249	181
	o-dichlorobenzene	181	1,531	1,153	867	656	494	372
	m-dichlorobenzene	173	2,393	1,758	1,291	948	697	510

(continued)

Table B2 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature (°F) 50	60	70	80	90	100
Halogenated hydrocarbons (cont'd)	benzyl chloride	179	2,792	2,061	1,520	1,125	830	612
	bromoform	149	507	386	294	224	171	131
	ethylene dibromide	131	348	255	188	138	101	74
	bromobenzene	155	2,144	1,521	1,079	764	542	384
Halogenated Ethers	2-chloroethyl ethyl ether	108	468	336	241	234	124	89
	Bis-(chloromethyl)ether	-	995	674	456	309	209	142
Nitrosamines	N-nitrosodimethylamine	151	385	280	204	163	148	107
	N-nitrosodiethylamine	177	2,529	1,836	1,330	966	700	508
Oxygenated hydrocarbons	acrolein	53	19	14	10	8	6	4
	glycidaldehyde	-	364	247	168	114	77	52
	propylene oxide	34	35	24	17	11	8	5
	butadiene diepoxide	-	1,426	1,009	714	506	358	253
	cyclohexene oxide	132	2,339	1,644	1,153	811	570	400
	styrene oxide	194	5,370	3,926	2,870	2,094	1,531	1,119
	phenol	183	2,071	1,490	1,072	769	554	398
	acetopheonone	202	3,191	2,382	1,778	1,327	991	740
	β-propiolactone	57	721	514	366	261	186	132
Nitrogenous Hydrocarbons	nitromethane	101	45	34	25	19	14	11
	aniline	184	3,864	2,831	2,075	1,520	1,114	817
Sulfur Compounds	diethyl sulfate	208	40	29	21	15	11	8
	ethyl methane sulfate	86	5,093	3,681	2,564	1,914	1,384	998

(continued)

Table B2 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature (°F) 50	60	70	80	90	100
Amines	dimethylamine	7.4	9	6	4	3	2	1
	isobutylamine	69	71	47	34	23	16	11
	t-butylamine	89	6	5	4	3	2	1
	di-(n-butyl)amine	159	9,506	7,096	4,775	3,105	2,168	1,462
	pyridine	115	378	267	189	134	95	67
	aniline	184	8,128	5,559	3,793	2,588	1,766	1,205
Ethers	diethyl ether	34.6	29	21	15	11	8	5
	propylene oxide	35	13	9	7	5	4	3
Esters	ethyl acetate	77	162	108	72	48	32	22
	methyl acrylate	80	164	111	75	50	34	23
	methyl methacrylate	100	736	484	318	209	137	90
Ketones	acetone	56	25	17	12	8	6	4
	methyl ethyl ketone	80-2	82	57	39	27	19	13
	methyl vinyl ketone	81	84	58	40	28	19	14
	acetophenone	202	5,346	3,855	2,767	2,000	1,439	1,037
Aldehydes	acetaldehyde	20	3	2	2	1	0.9	0.7
	benzaldehyde	179	7,586	5,152	3,507	2,382	1,622	1,101
Alcohols	methanol	64.7	1	1	0.8	0.6	0.4	0.3
	n-propanol	97.4	27	20	14	10	7	5
	allyl alcohol	97	32	23	16	11	8	6

(continued)

Table B2 (cont'd)

Chemical Class	Compound	b.p. (°C)	Temperature (°F)					
			50	60	70	80	90	100
Aromatics	benzene	80.1	108	77	54	38	27	19
	toluene	110.6	494	348	245	173	122	86
	ethylbenzene	136.2	1,393	984	693	487	344	243
	cumene	152.4	3,076	2,163	1,525	1,067	750	527
Hydrocarbons	*n*-hexane	68.7	32	23	17	12	9	6
	n-heptane	98.4	143	104	75	55	39	29
	1-hexene	63.5	28	20	15	11	8	6
	1-heptene	93.6	286	196	135	93	64	44
	2,2-dimethylbutane	49.7	0.5	0.4	0.3	0.2	0.2	0.1
	2,4-dimethylpentane	80.5	435	252	146	84	49	28
	4-methyl-1-pentene	53.8	14	10	8	6	4	3
	cyclohexane	80.7	49	36	26	19	14	10
Inorganic gases	nitric oxide	-	0	0	0	0	0	0
	nitrogen dioxide	-	0	0	0	0	0	0
	chlorine	-	0	0	0	0	0	0
	sulfur dioxide	-	0.06	0.05	0.03	0.02	0.02	0.01
	water	100	0.06	0.05	0.04	0.03	0.01	0

[a] Breakthrough volume is given in ℓ/2.2 g Tenax GC used in sampling cartridges.

volume has subsequently been established. Thus, the last portion of the sampling period is selected which represents the volume of air sampled prior to breakthrough for calculating their concentration. For cases in which the identity of a volatile organic compound is not known until after glc/ms, the breakthrough volume is subsequently determined.

Previous experiments have shown that the organic vapors collected on Tenax GC sorbent are stable and can be quantitatively recovered from the cartridge samplers up to 4 weeks after sampling when they are tightly closed in cartridge holders and placed in a second container that can be sealed, protected from light and stored at 0°C (1,2).

8.4 Analysis of Samples

The instrumental conditions for the analysis of volatile organics on the sorbent Tenax GC sampling cartridge is shown in Table B3. The thermal desorption chamber and the six port valco valve are maintained at 270° and 240°, respectively. The glass jet separator is maintained at 240°. The mass spectrometer is set to scan the mass range from 25-350. The helium purge gas through the desorption chamber is adjusted to 15-20 ml/min. The nickel capillary trap on the inlet manifold is cooled with liquid nitrogen. In a typical thermal desorption cycle, a sampling cartridge is placed in the preheated desorption chamber and the helium gas is channeled through the cartridge to purge the vapors into the liquid nitrogen capillary trap [the inert activity of the trap has been shown in a previous study (5)]. After the desorption has been completed, the six-port valve is rotated and the temperature on the capillary loop is rapidly raised (greater than 10°/min); the carrier gas then introduces the vapors onto the high resolution gc column. The glass capillary column is temperature programmed from ambient to 240°C at 4°C/min and held at the upper limit for a minimum of 10 min. After all the components have been eluted from the capillary column, the analytical column is then cooled to ambient temperature and the next sample is processed (2).

An example of the analysis of volatile organics in ambient air is shown in Figure B3 and the background from a blank cartridge is shown in Figure B4. The high resolution glass capillary column was coated with SE-30 stationary which is capable of resolving a multitude of compounds

Table B3. OPERATING PARAMETERS FOR GLC-MS-COMP SYSTEM

Parameter	Setting
Inlet-manifold	
desorption chamber	270°C
valve	240°C
capillary trap - minimum	-195°C
maximum	+180°C
thermal desorption time	4 min
GLC	
100 m glass SCOT-SE-30	25-240°C, 4/C° min
carrier (He) flow	∿3 ml/min
transfer line to ms	240°C
MS	
scan range	$\underline{m}/\underline{e}$ 25 → 300
scan rate, automatic-cyclic	1 sec/decade
filament current	300 μA
multiplier	6.0
ion source vacuum	$\sim 4 \times 10^{-6}$ torr

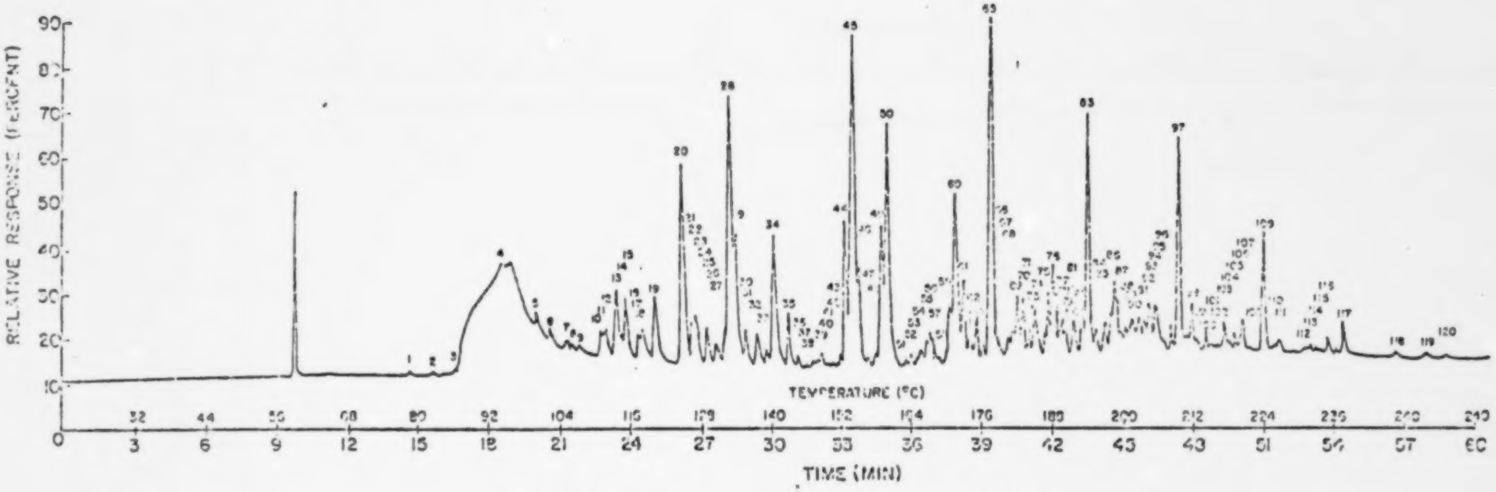


Figure B3. Profile of ambient air pollutants for Wood River, IL using high resolution gas chromatography/mass spectrometry/computer.

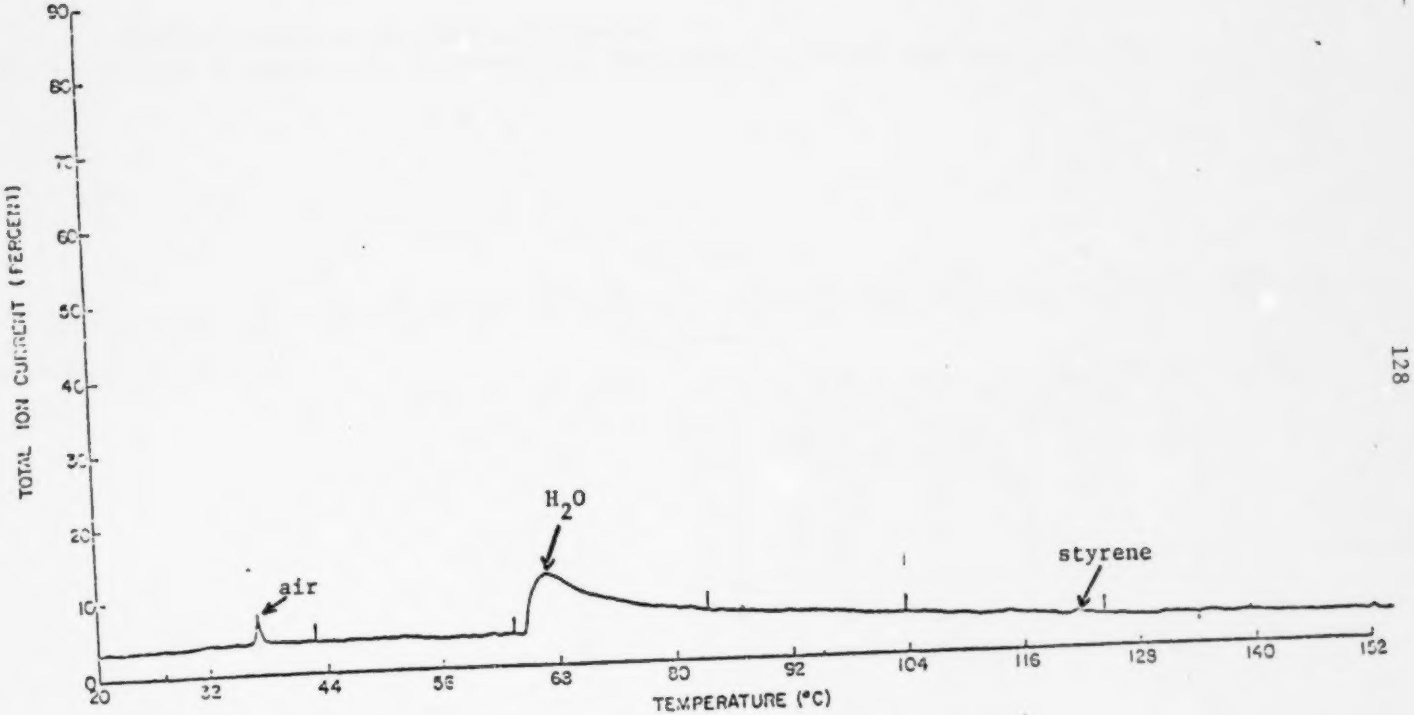


Figure B4. Background profile for Tenax GC cartridge blank

to allow their subsequent identification by ms/comp techniques; in this case over 120 compounds were identified in this chromatograph.

8.4.1 Operation of the MS/COMP System (Figure B5)

Typically the mass spectrometer is first set to operate in the repetitive scanning mode. In this mode the magnet is automatically scanned exponentially upward from a preset low mass to a high mass value. Although the scan range may be varied depending on the particular sample, typically the range is set from m/e 25 to m/e 300. The scan is completed in approximately 1.8 seconds. At this time the instrument automatically resets itself to the low mass position in preparation for the next scan, and the information is accumulated by an on-line 620/L computer and written onto magnetic tapes or the dual disk system. The reset period requires approximately 2.0 seconds. Thus, a continuous scan cycle of 3.8 seconds/scan is maintained and repetitively executed throughout the chromatographic run. The results is the accumulation of a continuous series of mass spectra throughout the chromatographic run in sequential fashion.

Prior to running unknown samples, the system is calibrated by introducing a standard substance, perfluorokerosene, into the instrument and determining the time of appearance of the known standard peaks in relation to the scanning magnetic field. The calibration curve which is thus generated is stored in the 620/L computer memory. This calibration serves only to calibrate the mass ion over the mass scanning range.

While the magnet is continuously scanning, the sample is injected and automatic data acquisition is initiated. As each spectrum is acquired by the computer, each peak which exceeds a preset threshold is recognized and reduced to centroid time and peak intensity. This information is stored in the computer core while the scan is in progress. In addition, approximately 30 total ion current values and an equal number of Hall probe signals are stored in the core of the computer as they are acquired. During the two-second period between scans this spectral information, along with the spectrum number, is written sequentially on disks, and the computer is reset for the acquisition of the next spectrum.

This procedure continues until the entire gc run is completed. By this time there are from 800-1400 spectra on the disk which are then subsequently processed. Depending on the information required, that day

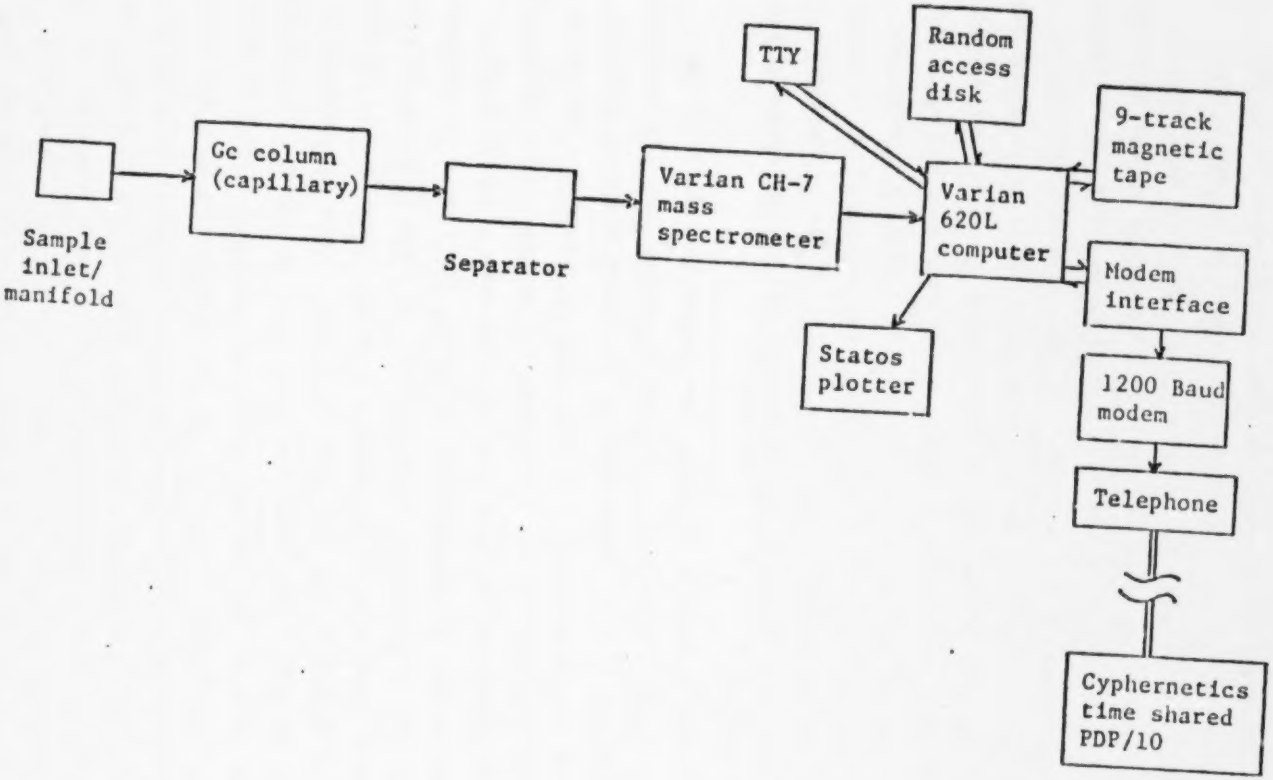

Sample inlet/ manifold
Gc column (capillary)
Separator
Varian CH-7 mass spectrometer
TTY
Random access disk
Varian 620L computer
9-track magnetic tape
Modem interface
Statos plotter
1200 Baud modem
Telephone
Cyphernetics time shared PDP/10

Figure B5. **Schematic diagram of gc-ms computer system.**

may then either be processed immediately or additional samples may be run, stored on magnetic tape and the results examined at a later time.

The mass spectral data are processed in the following manner. First, the original spectra are scanned and the total ion current (TIC) information is extracted. Then the TIC intensities are plotted against the spectrum number on the Statos 31 recorder. The information will generally indicate whether the run is suitable for further processing, since it provides some idea of the number of unknowns in the sample and the resolution obtained using the particular gc column conditions.

The next stage of the processing involves the mass conversion of the spectral peak times to peak masses which is done directly via the dual disk system. The mass conversion is accomplished by use of the calibration table obtained previously using perfluorokerosene. Normally one set of the calibration data is sufficient for an entire day's data processing since the characteristics of the Hall probe are such that the variation in calibration is less than 0.2 atomic mass units/day. A typical time required for this conversion process for 1,000 spectra is approximately 30 min.

After the spectra are obtained in mass converted form, processing proceeds either manually or by computer. In the manual mode, the full spectrum of scans for the gc run is recorded on the Statos 31 plotter. The TIC information available at this time is most useful for deciding which spectra are to be analyzed. At the beginning of the runs where peaks are very sharp nearly every spectrum must be inspected individually to determine the identity of the component. Later in the chromatographic run when the peaks are broader only selected scans need to be analyzed.

Identification of resolved components is achieved by comparing the mass cracking patterns of the unknown mass spectra to an eight major peak index of mass spectra (9). Individual difficult unknowns are searched by the use of the Cornell University STIRS and PBM systems. Unknowns are also submitted to EPA MSSS system for identification. When feasible, the identification of unknowns are confirmed by comparing the cracking pattern and elution temperatures for two different chromatographic columns (SE-30 and Carbowax SCOT capillaries) for the unknown and authentic compounds. The relationship between the boiling point of the identified halogenated hydrocarbon and the elution temperature on a non-polar column (the order of elution of constituents is predictable in homologous series since the SE-30 SCOT capillary separates primarily on the basis of boiling point) is carefully considered in making structure assignments.

Mass spectral search programs are operational at the Triangle Universities Computation Center (TUCC). RTI maintains twice daily service to TUCC, which is a one-quarter mile distance from the RTI campus. Additional information about each magnetic tape containing the mass spectra of halogenated hydrocarbons is entered directly into the TUCC job stream using a remote job entry processing. This is normally done at TUCC using one of the five terminals located within the Analytical Sciences Laboratory. The control information contains selected spectrum numbers of instructions to process entire gc runs. The computer program systems compare simultaneously either the entire library of 25,000 compounds or some subset of this library. The complete reports showing the best fits for each of the unknowns is produced at TUCC and printed out at the high speed terminals located on the RTI campus of TUCC. Thus, the processing of the mass spectral data obtained for the halogenated hydrocarbons in the samples collected is processed by one of three routes. Each consists of a different level of effort. The first level is strictly a manual interpretation process which proves to be the most thorough approach. The second level is executed when the interpretation at the first level has not yielded conclusive results.

8.4.2 Quantitative Analysis

In many cases the estimation of the level of pollutants by capillary gas chromatography in combination with mass spectrometry is not feasible utilizing only the total ion current monitor (See Figure B3 for example). Since baseline resolution between peaks is not always achieved, we employ the techniques which have been previously developed under contract whereby full spectra are obtained during the chromatographic separation step and the selected ions are presented as mass fragmentograms using computer software programs which allow the possibility of deconvoluting constituents which were not resolved in the total ion current chromatogram (6). Examples are depicted in Figures B6 and B7 which represent an ambient air sample with a TIC profile as in Figure B3.

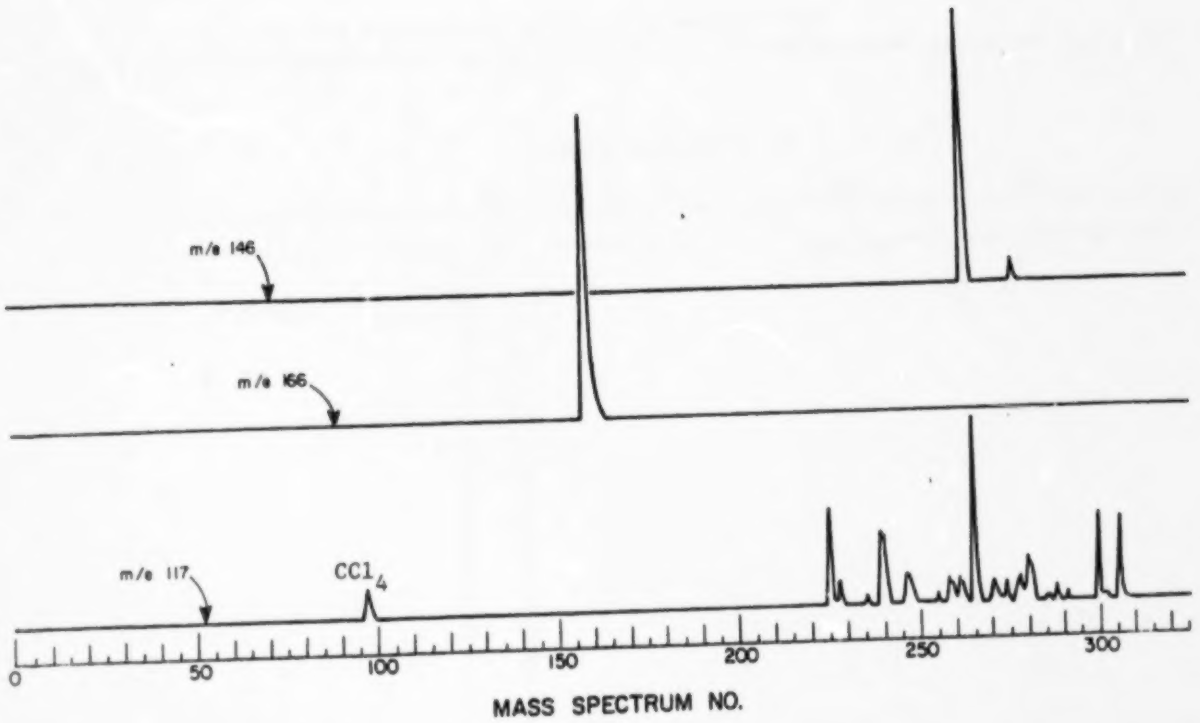


Figure B6. Mass fragmentograms of characteristic ions representing carbon tetrachloride (m/e 117), tetrachloroethylene (m/e 166) and m-dichlorobenzene (m/e 146) in ambient air.

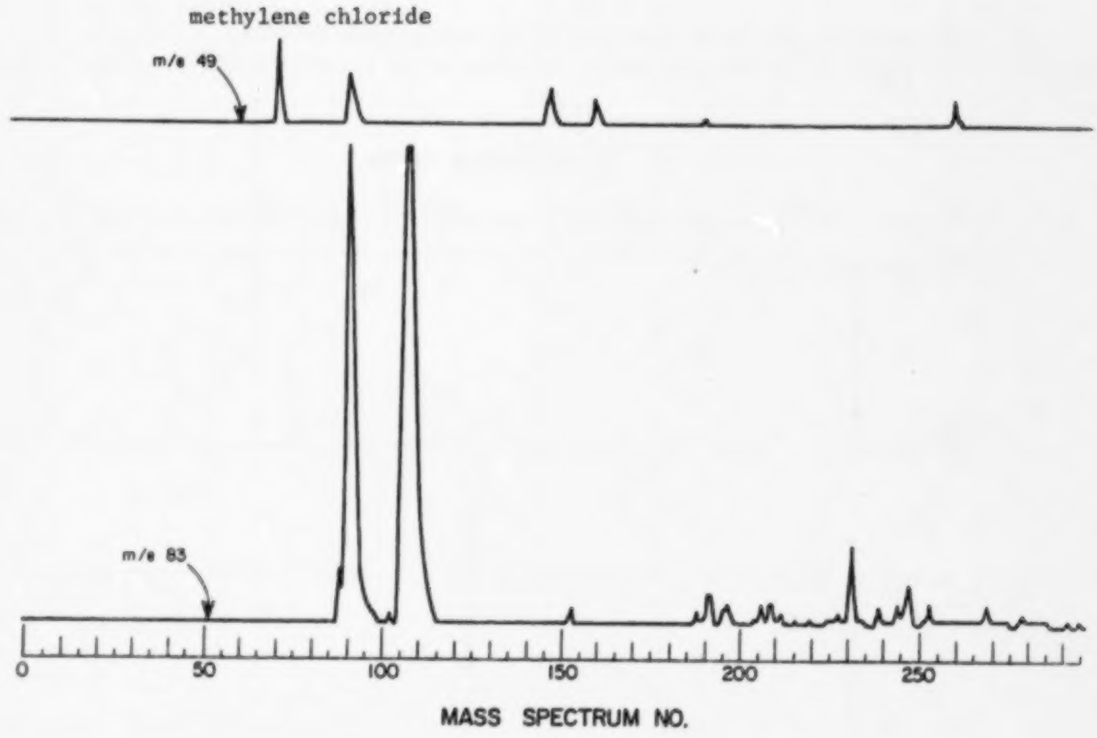


Figure B7. Mass fragmentograms of characteristic ion representing methylene chloride (m/e 49) and chloroform (m/e 83) in ambient air.

In our gc/ms/comp system, we request from the Varian 620/L dedicated computer mass fragmentograms for any combination of m/e ions when full mass spectra are obtained during chromatography; thus selectivity is obtained by selecting the unique ion for that particular organic substance and this is represented vs. time with subsequent use of that ion intensity for quantitation. Also quantitation with *external standards* is easily achieved using the intensity of the total ion current monitor or the use of a unique mass cracking ion in a mass spectrum of the external standard. Thus, we use mass fragmentography for the quantitation of organics in ambient air when the total ion current monitor is inadequate because of the lack of complete resolution between components in the mixture.

As described previously, the quantitation of constituents in ambient air samples is accomplished either by utilizing the total ion current monitor or where necessary the use of mass fragmentograms. In order to eliminate the need to obtain complete calibration curves for each compound for which quantitative information is desired, we use the method of relative molar response (RMR) factors (10). Successful use of this method requires information on the exact amount of standard added and the relationship of RMR (unknown) to the RMR (standards). The method of calculations is as follows:

$$(1)\quad \mathrm{RMR}_{\mathrm{unknown/standard}} = \frac{A_{\mathrm{unk}}/\mathrm{Moles}_{\mathrm{unk}}}{A_{\mathrm{std}}/\mathrm{Moles}_{\mathrm{std}}}$$

A = peak area, determined by integration or triangulation.

The value of RMR was determined from at least three independent analyses.

$$(2)\quad \mathrm{RMR}_{\mathrm{unk/std}} = \frac{A_{\mathrm{unk}}/g_{\mathrm{unk}}/\mathrm{GMW}_{\mathrm{unk}}}{A_{\mathrm{std}}/g_{\mathrm{std}}/\mathrm{GMW}_{\mathrm{std}}}$$

A = peak area, as above
g = number of grams present
GMW = gram molecular weight

Thus, in the sample analyzed:

$$(3)\quad g_{\mathrm{unk}} = \frac{A_{\mathrm{unk}}\ \mathrm{GMW}_{\mathrm{unk}}\ g_{\mathrm{std}}}{A_{\mathrm{std}}\ \mathrm{GMW}_{\mathrm{std}}\ \mathrm{RMR}_{\mathrm{unk/std}}}$$

The standard added can be added as an internal standard during sampling, however, since the volume of air taken to produce a given sample is accurately known, it is also possible and more practical to use an external standard whereby the standard is introduced into the cartridge prior to its analysis. Two standards, hexafluorobenzene and perfluorotoluene are used for the purpose of calculating RMR's. From previous research it has been determined that the retention times for these two compounds are such that they elute from the glass capillary column (SE-30) at a temperature and retention time which does not interfere with the analysis of unknown compounds in ambient air samples.

Since the volume of air taken to produce a given sample is accurately known and an external standard is added to the sample, then the weight can be determined per cartridge and hence the concentration of the unknown. The approach for quantitating ambient air pollutants requires that the RMR is determined for each constituent of interest. This means that when an ambient air sample is taken, the external standard is added during the analysis at a known concentration. It is not imperative at this point to know what the RMR of each of the constituents in the sample happens to be. However, after the unknowns are identified then the RMR can be subsequently determined and the unknown concentration calculated in the original sample using the RMR. In this manner it is possible to obtain qualitative and quantitative information on the same sample with a minimum of effort.

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Written analytical protocol prepared 1/24/77.